DOCUMENT RESUME

ED 427 942 SE 061 993

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TITLE	Changing What We Do: Constructing a Team-Based, Problem-Centered Professional Development Experience.
INSTITUTION	North American Association for Environmental Education, Troy, OH.
SPONS AGENCY	National Science Foundation, Arlington, VA.
ISBN	ISBN-1-884008-59-3
PUB DATE	1998-00-00
NOTE	203p.
CONTRACT	ESI-9355551
AVAILABLE FROM	NAAEE's Conference, Publications, & Membership Office, 410 Tarvin Road, Rock Spring, GA 30739; Tel: 706-764-2926; Fax: 706-764-2094; e-mail: CSmith410@aol.com ($19 nonmembers; $14 members).
PUB TYPE	Guides - Classroom - Teacher (052) -- Reports - Descriptive (141)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Community Involvement; *Curriculum; Elementary Education; *Environmental Education; Higher Education; Nonformal Education; Outdoor Education; *Professional Development; *Teacher Education

ABSTRACT

Incorporating community-based programs into the curriculum provides rich, real learning experiences. The VINE (Volunteer-led Investigations of Neighborhood Ecology) Follow-Through Project allows third through fifth grade students to work with trained volunteers in guided inquiries on the ecological habitats found in the schoolyard and the community. This book presents a problem-centered professional development experience and describes how teams of formal and nonformal educators and administrators worked together over 14 months to implement the VINE Follow-Through Project. The model is conducted over a two-year cycle which includes two summer institutes. Vignettes from administered projects in Seattle, Louisville, and Broward County, Florida are scattered throughout the guide to supplement and provide concrete examples of the program. A series of appendices list materials needed to conduct a local VINE project. This program is aligned with the National Science Education Standards for professional development. (SJR)

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Changing What We Do

Constructing A Team-Based, Problem-Centered Professional Development Experience

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By Karen S. Hollweg
and Carole Kubota
with Phyllis Ferrell

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Changing What We Do

Constructing A Team-Based, Problem-Centered Professional Development Experience

by Karen S. Hollweg
and Carole Kubota
with Phyllis Ferrell

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NAAEE
NORTH AMERICAN ASSOCIATION FOR ENVIRONMENTAL EDUCATION

Changing What We Do: Constructing A Team-Based, Problem-Centered Professional Development Experience tells about a 2 1/2 year experiment called the VINE Follow-Through Project. Teams of educators worked together on this project, integrated VINE (**V**olunteer-led **I**nvestigations of **N**eighborhood **E**cology) into ongoing classroom curricula, and provided students with opportunities to build on their experiences as they developed skills and conceptual understandings. The strategies and materials used by the teams are documented here.

We encourage educators who want to integrate real-world learning experiences into the ongoing curriculum and/or work with others on meaningful educational challenges to apply these strategies and materials to their efforts. And we would very much like to hear about your experiences.

For additional information about this publication, VINE Program materials, or other programs and publications of the North American Association for Environmental Education, please contact

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This material is based upon work supported, in part, by the National Science Foundation under Grant No. ESI-9355551. Opinions expressed are those of the authors and not necessarily those of the Foundation.

Design: Sans Serif Graphics
Editor: Paula Tarnapol Whitacre
Production Manager and Editorial Assistant: Marisa Corso
Published by the North American Association for Environmental Education, Washington, D.C.

ISBN 1-884008-59-3

Printed in the United States of America on recycled paper with soy ink.

WHO IS THIS BOOK FOR?

If you are a teacher, curriculum specialist, nonformal* educator, or university faculty member who wants to solve a problem or deal with educational improvements that are difficult to tackle alone, this book is for you. It tells about the VINE Follow-Through Project, which involved multi-faceted teams of formal and nonformal educators from Seattle, Washington; Broward County, Florida; and Louisville, Kentucky; in meeting a commonly developed goal. Our goal was to integrate special out-of-the-classroom educational experiences into the ongoing classroom/district curriculum.

We believe that the Follow-Through approach can be adapted and used to build into the ongoing curriculum other community-based programs that provide rich, real-world learning experiences – and can also be used to tackle other educational challenges that concern a diverse group of educators, such as you and your colleagues, and that require you to change what you are now doing.

WHERE SHOULD I BEGIN?

Don't start at page one and read straight through, unless that path makes sense to you. **Please choose the particular section that interests you most and start there.** For example,

- If you want to first learn about the outcomes — what the external evaluators found regarding classroom practice and effective team strategies, what happened in the classrooms of participating teachers, how this professional development experience affected the non-teacher participants, start with the second section.

- If you want to know how this project came about, its underpinnings/rationale, and its overall design and funding, start with the first section.

- If, on the other hand, you want to jump right into our story — the sequential narrative of what we did and how we did it, begin with the third section.

The Table of Contents shows all the parts, and we encourage you to **proceed in the sequence that makes most sense and will be most helpful to you.**

---

* *We recognize that a variety of institutions provide programs like VINE to schools. Museums and environmental educators call theirs "nonformal" education programs or institutions. On the other hand, science centers and the National Science Foundation use the term "informal." We have chosen to use the term "nonformal" throughout this publication to refer to educators and institutions (such as nature and science centers, museums, nonprofit organizations and even government agency and media-sponsored programs) that supplement the educational efforts of the formal K-12 schools.*

ACKNOWLEDGMENTS

The work of many people who committed their time and talent to the VINE Follow-Through Project is reflected in this publication. Their learnings, and ours, are distilled and described on the following pages. We thank all the members of the Seattle, Kentucky, and South Florida Teams some of whom worked literally for years on the project and lived through the stories you will read about here. We give our gratitude to the Advisory Committee for helping us to shape VINE Follow-Through and pushing us to do our best. We also genuinely appreciate our External Evaluators, who helped us to step back and look at the project through a critical lens.

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Phyllis Ferrell helped us by interviewing classroom teachers and writing vignettes based on her interviews. Four other talented, patient and persevering individuals – Marisa Corso, Blythe Dim, Kristin Jenkins, and John McComb – have played a major role in the production of this volume and the support of this project. To them we also extend our sincerest thanks.

Karen Hollweg
VINE Follow-Through Project
Principal Investigator and Project Director

Carole Kubota
VINE Follow-Through Project
Co-Principal Investigator

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What do teachers, administrators, university and nonformal educators think about this kind of professional development?

My experience as a member of the team has awakened new patterns of thought and behavior, created a higher level of self-esteem, forced me to accept higher levels of professional standards, and given me the opportunity to meet with, listen to, and learn from a number of creative and intellectually gifted individuals.

One of the perks of VINE Follow-Through is being allowed the time to interact with other educators. It enriches our teaching.

We came to this professional development experience expecting to receive a huge box of tools. When we opened the box, we found it empty. After the disappointment and frustration passed, we realized that because it was empty, we had everything! . . . that we could fill it with all the tools that were useful for our situation.

I have spent less time in direct instruction with my whole class. I'm giving my students more freedom to choose and responsibility in directing their own efforts...I'm nervous with it, but the students are loving it.

I've learned more about myself and how and why I can be a better team member and thus teach my students more about team work and cooperation.

The power of this project has been to enable teachers to reflectively merge hands-on activities into minds-on curriculum. The result is a much more powerful learning tool.

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I have broadened my goals. Now the student learning often goes way beyond my expectations and at times in a different direction. I have given my students more freedom to design their products and have been pleased with the peer-to-peer learning that has taken place. I am now more concerned with science process skills as well as science content and interdisciplinary applications.

I was surprised by the tenacity with which we cling to our set ways. We wanted to continue our mode of using neat hands-on activities ... without reflecting on what the big picture outcome would be.

I changed my view from being a *consultant*, the expert called in to advise on particular things, to being a true team member who wrestled together with the others on an *equal* basis over tough problems we had to work out.

The collegiality ... would not let me be self-satisfied or quit.

We observed that students can generate their own questions and solve problems, be excited and disciplined, extend and apply their own learning, have ownership, teach each other, have a good self-image, make decisions, self assess, work well as a group, and learn from their own mistakes.

My teaching style has changed. I plan and teach with constructivism in mind. I create activities which require students to actively participate in small groups, enabling them to feel and be in control of their own projects. Collaboration is extremely effective.

To learn what we did, you must be a part of it. You can't just 'teach' it in an inservice workshop. I'd like to try to be part of a new team and help them through developing and achieving their own goal.

One thing that got me charged was watching us all struggle with new ideas and becoming comfortable with the struggle.

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People change by doing new things in conjunction with others.

FULLAN AND STIEGELBAUER, 1991

The Project's Design and Theoretical Underpinnings

Changing What We Do describes how teams of formal and nonformal educators and administrators, working together over fourteen months or more, can successfully build hands-on learning experiences provided by community groups into the ongoing classroom curriculum in a way that enables students to *do* more science and construct meaning from their experiences. Through the VINE Follow-Through Project, classroom teachers moved to more progressive teaching practices and assessment strategies. Participants concerned with many different aspects of education shared leadership and engaged in the kind of standards-based professional development that supports and empowers professionals in reforming education.

We (the co-authors who served as the project's co-investigators) have documented here what project participants did and learned, because we believe that **the Follow-Through approach can be adapted and used to build into the ongoing curriculum other community-based programs that provide rich, real-world learning experiences.** It can also be used to address any authentic challenge that concerns a diverse group of educators. We encourage you to try it, and hope you will inform us of your experiences.

The following pages describe the vision for this project, set forth its theoretical underpinnings and design, and provide an overview of its essential elements.

ORIGIN, PURPOSE, AND VISION

The VINE Follow-Through Project expands on the original VINE Program (Volunteer-led Investigations of Neighborhood Ecology). VINE Programs, like many others brought into schools by nonformal education institutions, enable children and their teachers to engage in novel inquiry experiences that would otherwise be unavailable. In the case of VINE, the inquiry occurs outdoors on the school grounds and involves ecological concepts.

Through VINE Programs, third through fifth graders in cities across the country go out into their schoolyards five or more times during the year with trained volunteers. Together they engage in guided inquiries to discover the diverse array of tiny animals and plants living there and some ecological interrelationships. Participants discover, for example, who eats what, the amount of organic matter in the soil and how it gets there, ways in which habitats differ, and ways that people affect the plants, animals, and their habitats. The classroom teacher circulates and oversees his or her students. About 55 percent of the youngsters who have participated in VINE Programs nationwide are members of cultural and/or ethnic minorities and 30 percent live at or below the poverty level. In each city, a local VINE Program coordinator, typically a paid staff member of a nonformal institution, makes this happen. The coordinator is responsible for volunteer recruitment and training, scheduling, and the materials that the volunteers and youngsters use in their investigations.*

Since 1993, the VINE Program has been a part of the North American Association for Environmental Education (NAAEE), and NAAEE has sponsored a Network of local VINE coordinators. Through the VINE Network, local coordinators share successes, frustrations, and dreams, and get new ideas to improve their local programs. The idea for the VINE Follow-Through Project originated during discussions among coordinators at NAAEE annual conferences.

THE PROJECT'S CHALLENGE

To build special hands-on learning experiences into the ongoing classroom curriculum in a way that enables students to do more science and construct meaning from their experiences.

Coordinators with well-established VINE Programs wanted to address a problem: how to build the schoolyard investigations into the ongoing classroom curriculum. By following through on the investigations, the coordinators felt that children could learn even more from their experiences and make more sense of the things they were doing and discovering outdoors.

Participating classroom teachers, in response to an evaluation of the VINE Program in three cities, also expressed an interest in building on

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For more information about the VINE Program, a list of outdoor investigations used, and/or an order form describing materials available to support program start-up, contact NAAEE at 937-676-2514 or visit VINE's web site at http://www.naaee.org/html/vine.html.

their students' VINE experiences (Burruss, Judson, and Harris, 1994). The teachers were not science advocates or experts. In fact, only 41 percent of the 82 teachers responding had received specific training in teaching science, and only 24 percent preferred teaching science over any other subject area. Nevertheless, a large majority, 78 percent, wanted to work with other teachers to improve their science program. They had been influenced by seeing their students' enthusiasm and genuine interest in the schoolyard investigations.

To address the demand in a comprehensive and systemic way, VINE coordinators and NAAEE staff knew it would be important to work not only with teachers, but also with school district curriculum specialists and university education and professional development specialists. The school districts' curriculum specialists and coordinators have spent years designing frameworks and identifying teaching resources for different curriculum areas and grade levels. They are responsible for implementing these throughout their districts and for interfacing with the nonformal education institutions that want to partner with the schools. They have a large personal and professional stake in the identified challenge of building hands-on experience into the curriculum. University faculty — expected to keep up with the literature, conduct research, and teach courses — have few opportunities to interact with teachers or district administrators in multi-year, collaborative projects that truly put theory into practice. They, too, could contribute to and benefit from a potential follow-up to the VINE Program.

Karen Hollweg, NAAEE's VINE Network coordinator, and Anita Lagerberg, Seattle's VINE Program coordinator, organized an exploratory meeting in Seattle in 1993 with a group of experienced, respected school district and university educators to discuss the vision and assess their interest in starting a VINE Follow-Through Project. Subsequently, Karen, Anita, Carole Kubota (University of Washington), and Bob Wright (Seattle Public Schools) agreed to work together crafting a proposal to support a solution that was functional and well-grounded. VINE Program coordinators in four additional cities were also eager to participate. **We envisioned working with classroom teachers to embed their students' outdoor investigations in additional opportunities to *do* science and pursue an important concept and/or set of skills** by getting children to

- think out loud about their preconceived notions and observations,
- develop alternative explanations and hypotheses, and
- design and conduct further experiments to answer additional questions.

UNDERPINNINGS AND RATIONALE

Watson and Konicek (1990), as well as others, have published articles showing that thinking and trying out new observations and ideas in multiple contexts is essential if students are to "make connections" and develop new conceptual understandings – i.e., if hands-on investigative experiences are to have a "significant effect" and be viewed as more than "a series of unrelated episodes." Other researchers (Lemke, 1990; Minstrell, 1989; Saunders, 1992) have also written about the importance of such learning opportunities, explaining that they are necessary if students are to experience and thereby learn about "the nature of science as a human activity," and not just learn about science as a subject.

> **"The ultimate goal is changing the culture of learning.... Learning requires the active participation of the learner.... (and) requires individual(s) to work out their own meaning." Fullan and Stiegelbauer (1991)**

To provide students with the kinds of experiences emphasized by these researchers, we envisioned, for VINE Follow-Through, a new kind of professional development effort that was problem-centered and team-based. The "problem" was clear. While community groups were offering outdoor, hands-on learning experiences to schools, these experiences were not built into the ongoing curriculum in ways that enabled students to do more science or to construct meaning from the additional experiences.

To address the problem, the VINE Follow-Through Project offered a team-based approach, with each team composed of people from diverse organizations. Many of these people — teachers, staff from nonformal education institutions, university faculty, curriculum administrators — were not used to the collaborative nature envisioned in the term "team-based." Thus, through VINE Follow-Through, they would learn skills not only to integrate outside inquiry into the classroom curriculum but also to work together as an ongoing collegial team.

The literature drawn upon in designing VINE Follow-Through came from the business and education worlds. The business world provided information on teams and how they work. The education world provided information on how best to enable students to construct meaning from their science experiences. Both disciplines informed us about how individuals change.

Fullan's Eight Basic Lessons of the New Paradigm for Change

1. **You can't mandate what matters.**
2. **Change is a journey not a blueprint.**
3. **Problems are our friends.**
4. **Vision and strategic planning come later.**
5. **Individualism and collectivism must have equal power.**
6. **Neither centralization nor decentralization works.**
7. **Connection with the wider environment is critical for success.**
8. **Every person is a change agent.**

First, Michael Fullan's explanations of the Eight Basic Lessons of the New Paradigm for Change (1993) helped us to understand further what we were aiming for as we designed this different kind of professional development project.

In addition we took to heart the words of Fullan and Steigelbauer in *The New Meaning of Educational Change* on the role of professional development in improving schools and reforming education (see box above). The authors were talking about teachers as learners who **need to work out their own meaning** to change what happens with students in their classes. But to us, they were also describing what school district specialists, university faculty, and nonformal educators need to leave their positions of authority and work with teachers *as colleagues* and what children need in order to learn new concepts and skills. The philosophical base of the VINE Follow-Through Project depends on the similarity in what educational experts know at this time about the "process of change" in educational systems and individuals' "learning"

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by way of constructivism. Our goal was to create a problem-centered professional development experience that would enable participants to **develop concepts of teaching and learning** in the same way that project-based learning gives children opportunities to actively acquire new concepts and skills.

From education research, we also relied on the **Concerns-Based Adoption Model (CBAM)** set forth in *Taking Charge of Change* (Hord, et al., 1987), which identifies seven kinds of concerns expressed by individuals involved in change. The authors' studies showed that as people implemented an innovation, their concerns tended to shift from self-concerns to concerns regarding the innovation they were implementing and finally to concerns regarding the impact or effectiveness of the innovation. These findings guided us in providing the kinds of information and interventions that might be most useful to participants as the project progressed. In the VINE Follow-Through Project, the innovation is the professional development experience itself. As you continue through this publication, you will read about the strategies and interventions we used. The concerns expressed by participants at various stages are summarized in the table on pg. 100.

Stages of Concern: Typical Expressions of Concern about the Innovation

	Stages of Concern	Expressions of Concern
IMPACT	6 Refocusing	I have some ideas about something that would work even better.
	5 Collaboration	I am concerned about relating what I am doing with what other instructors are doing.
	4 Consequence	How is my use affecting kids?
TASK	3 Management	I seem to be spending all my time getting material ready.
SELF	2 Personal	How will using it affect me?
	1 Informational	I would like to know more about it.
	0 Awareness	I am not concerned about it (the innovation).

For insights on ways to deal with the kind of challenge we aimed to address and the kind of collegial problem-solving we hoped to promote, we turned to the business world. We drew upon Peter Senge and his work on the **use of teams to solve complex problems** in business. In *The Fifth Discipline* (1990), Senge points out that solving problems requires systems thinking, a mind shift to break out of old ruts, and trusting teams learning together. According to Senge,

> In dialogue, there is the free and creative exploration of complex and subtle issues, a deep "listening" to one another and suspending of one's own views. . . Dialogue can occur only when a group of people can see each other as colleagues in mutual quest for deeper insight and clarity. . . Seeing each other as colleagues and friends, while it may sound simple proves to be extremely important. We talk differently with friends. Treating each other as colleagues acknowledges the mutual risk and establishes the sense of safety in facing the risk.

Three years after we began planning VINE Follow-Through, the *National Science Education Standards* (NSES 1996) were published. It was gratifying to see that our approach was aligned with the assump-

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tions made by the Standards about the nature of professional development experiences. These assumptions include:

- The traditional distinctions between targets, sources, and supporters of teacher development are artificial.
- The conventional view of professional development for teachers needs to shift from technical training for specific skills to opportunities for intellectual professional growth.
- The process of transforming schools requires that professional development opportunities be clearly and appropriately connected to teachers' work in the context of the school.

VINE Follow-Through's Alignment with the NSES Standards

VINE Follow-Through is aligned with the following National Science Education Standards for professional development. For a more complete description, please see Appendix page E.4.

Standard A: Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry.

Standard B: Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching.

Standard C: Professional development for teachers of science requires building understanding and ability for lifelong learning.

Standard D: Professional development programs for teachers of science must be coherent and integrated.

Developing teams and changing styles of teaching and learning would require a long-term change effort. To be successful, VINE Follow-Through needed to address individual and group concerns, enable colleagues to work together as equals and friends, involve participants in evolutionary planning, and provide both pressure and support. By combining constructivist teaching and learning for professionals and elementary-age students with an approach that was grounded in the work of Fullan, CBAM, and Senge, we hoped we could successfully meet our challenge.

PROJECT OVERVIEW

As the Follow-Through Project began to take shape, it became clear that it was larger than a curriculum planning task for a team of educators during the summer. We envisioned a multi-year effort with teams of people from

- the nonformal education institution or community agency sponsoring the VINE Program,
- the classrooms participating in the program,
- the school district's curriculum offices, and
- a college or university.

These people would work together in new and different ways to provide children with constructivist learning opportunities.* We also wanted to involve teams from three cities, in order to enrich the experience for participants, see whether our model was robust enough to be applicable in different urban school districts and in states with varied educational mandates, and gain additional insights through comparative evaluation. We hoped to create a professional development process that could be used by museums, nature centers, and other nonformal education institutions that work with schools in virtually every city across the country.

An advisory committee of formal and nonformal educators and scientists (see page ii for a list of their names) helped hone this collaborative approach. By 1993–94, we felt confident enough in the value of the approach to apply for and receive a grant from the National Science Foundation's Elementary, Secondary and Informal Education Section. This funding paid for Summer Institutes and travel, coordination and exchange of ideas among the teams, external evaluation, and the development of a final publication. School district Eisenhower Funds, building-level professional development money, in-kind matches, and other local sources paid for the salaries of the local teams and materials they needed. (Appendix page D.2 provides a summary of each team's budget.)

VINE Follow-Through Project Timeline

The VINE Follow-Through Project, funded in part by the National Science Foundation and administered by the North American Association for Environmental Education, provided professional development, support, and materials to educational teams in Seattle, Louisville, and Broward County, Florida. Below is a rough timeline of the project's development.

1993: Initial discussions held in Seattle about what follow-up to the VINE Program could accomplish; proposal written.

1994: Funding received from the National Science Foundation; Seattle Design Team formed.

1994–95: Seattle Design Team, as the first Follow-Through team, participated in the first Summer Institute, designed and implemented follow-through plans, and planned and conducted a Summer Institute for teams from Kentucky, Florida, and additional participants from Seattle.

1995–96: Teams worked independently in each of the three cities and came together for a "lessons learned" Summer Institute in 1996; external evaluation of program effectiveness carried out.

1996–97: Vine Follow-Through activities continued in the three cities with local funding.

1998: Close-out of NSF-funded portion of VINE Follow-Through Project.

In addition to the inspiration for the project, Fullan and Steigelbauer provided a road map. They advocated "evolutionary planning": having a plan, but starting small; actively initiating the plan with both pressure and support; trying things; and then reflecting on and refining them.

So, in 1994–95, during the first year of the project, we worked intensively with just one team – the Seattle Design Team of ten people. Three people (Karen Hollweg, the project director from NAAEE; Carole Kubota, University of Washington; and Bob Wright, the school district science specialist) met periodically to plan the team's sessions,

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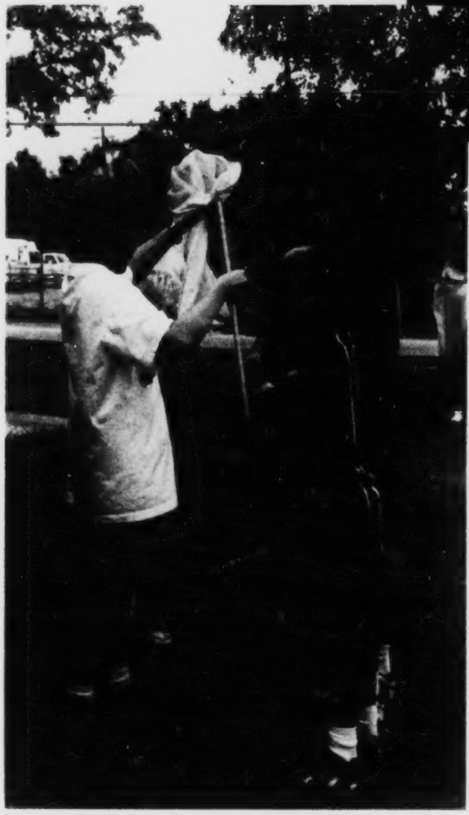
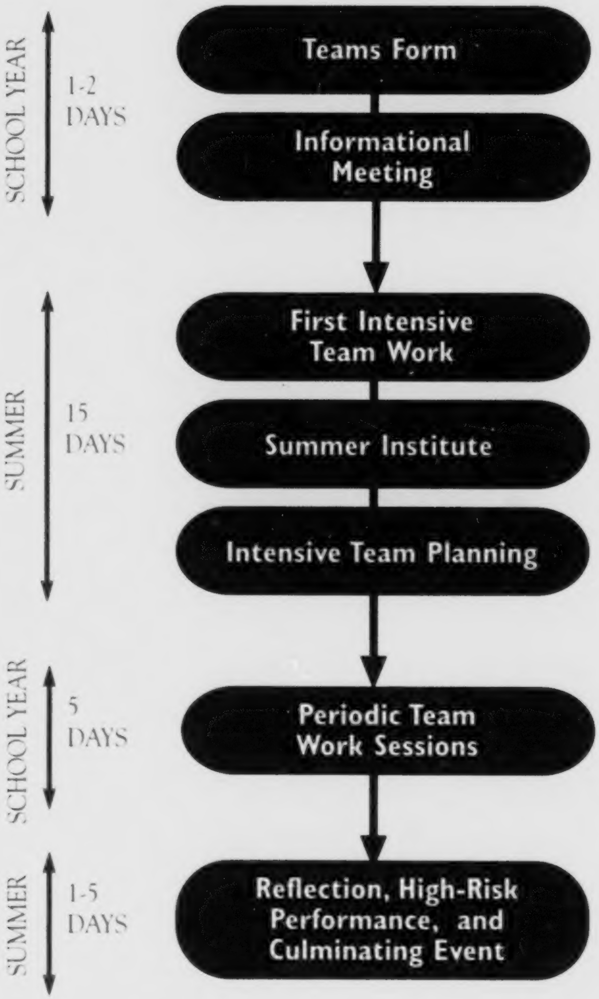
* *In brief, constructivism holds that a learner enters the process of learning with prior conceptions and must play an active role in acquiring new experiences that call those concepts into question. Through an ongoing process of discussion, additional experiences, and reflections, the learner can reconstruct the original ideas and create new understandings. See Appendix page H.1 for additional resources describing constructivist teaching and learning.*

VINE Follow-Through Challenge:
To build special hands-on learning experiences into the ongoing classroom curriculum in a way that enables students to *do* more science and construct meaning from their experiences.




SCHOOL YEAR
1-2 DAYS
Teams Form
Informational Meeting
SUMMER
15 DAYS
First Intensive Team Work
Summer Institute
Intensive Team Planning
SCHOOL YEAR
5 DAYS
Periodic Team Work Sessions
SUMMER
1-5 DAYS
Reflection, High-Risk Performance, and Culminating Event

assess progress, and attend to administrative and financial matters. The entire team collectively tackled the challenge and got to know and appreciate one another's skills. Periodic visits by the Advisory Committee members and our external evaluators provided us with fresh perspectives and probing questions – both challenging our thinking and adding new ideas.

By the end of the first year, the Design Team was ready to showcase its newly gained skills and understandings. The members took on the challenge of leading teams from South Florida and Kentucky, the other two school districts involved in the project, in a Summer Institute.

From the very beginning, the project leaders agreed that, to maintain the project's integrity, we had to consistently practice what we preached – i.e. to model the model. Our professional development efforts had to **follow the same constructivist principles that we expected classroom teachers to follow** with their children. We engaged in the process of addressing a real education problem in which we all had a stake. We were constructing new conceptual understandings, and we wanted students to engage in the same kind of learning process. So, just as the project leaders had used a constructivist approach with the Seattle Team in the first year, we all followed that pattern in subsequent years.

The diagram on page 8 sketches out our model for team-based, problem-centered professional development. It highlights the following essential elements:

- **Team formation** through one-on-one conversations and an informational meeting of all team members to explain the project and address questions
- **Intensive, active learning experiences** – three weeks that enable teams to:
    - get to know one another – the skills, interests, working styles and viewpoints of teammates – and come to trust and value each other;
    - identify concepts and skills appropriate for their students to develop via VINE Follow-Through;
    - work as a team to ask questions, discuss ideas, make decisions, and create real products together;
    - engage in a common, constructivist learning experience, as adults, and develop their understandings of constructivism by examining and reflecting on numerous examples; and
    - apply their new understandings to define a team goal and begin planning constructivist VINE Follow-Through experiences for their students that would meet their state/district requirements.

- **Periodic work sessions** at members' work sites throughout the school year to apply and assess the team's plan and to compare experiences, successes, and frustrations; reflect on their experiences; and make changes.
- **Opportunities to reflect** on the year **and demonstrate** new skills and understandings through an authentic, high-risk "performance," and culminating event.

The next two sections of this publication describe how this model developed in Seattle, Louisville, and South Florida. "Project Outcomes," beginning on the next page, provides a summary of the evaluation, vignettes from three classroom teachers, and statements from non-teachers describing how the project changed their professional practices. "What We Did," starting on page 35, details the VINE Follow-Through process, showing how the teams formed and began planning, participated in a Summer Institute, and implemented their plans during the 1995-96 school year.

Project Outcomes

You, your supervisor, and/or the people who fund you may be asking: Why should I spend time and effort to recruit and work with a team of educators? Given the cost of such a multi-year effort, what are the benefits? This section describes some of the outcomes of VINE Follow-Through, both inside and outside the classroom, and with teachers, other educators, and students. Perhaps these outcomes can help you envision some of the benefits that might result in your situation.

On pages iv - v, we presented a collage of comments from participants regarding the value of this project. They were taken from statements voiced during meetings or writings submitted during the course of the project. This section expands on those comments, drawing on **documents written by project participants and by the external evaluators**, to provide details regarding

- **strategies that the evaluators concluded were effective in forming teams and engaging team members in addressing the challenge,**
- **the impact of the teams' efforts on classroom teachers and ways in which team members changed what they and their students do in the classroom,** and
- **the growth experienced by the non-teacher members of the teams.**

We believe the evidence shows that the VINE Follow-Through approach achieved its goal of building VINE schoolyard learning experiences into the ongoing classroom curriculum in a way that enables students to do more science and construct meaning from their experiences. We hope it will convince you that this is an effective way to bring about change and will encourage you to try something similar.

WHAT THE PROJECT'S EXTERNAL EVALUATORS CONCLUDED

Our external evaluators, M. Jean Young and Susan Loucks-Horsley, provided feedback during the first two years of the project for the purpose of program improvement. During the last year, they focused on program effectiveness. These summative data are meant to inform those interested in implementing the VINE Follow-Through professional development model. The evaluation focused on two questions:

What strategies were effective in forming the teams and engaging them in designing Follow-Through learning experiences?

and

What is the impact of these strategies on the teachers and to what degree is change happening in their classrooms?

Data collected to assess program effectiveness came from site visits to the VINE Summer Institutes, interviews, document reviews, and pre-coded teacher logs. Teacher participants at three evaluation sites and several non-participating colleagues in their schools or in comparable schools completed teacher logs. The evaluators compared teacher-participants with a matched sample of non-participants in a control-treatment study. This enabled the evaluators to determine program effects related to classroom teaching.

What the Evaluators Learned About Team Building Strategies

As described throughout the narratives in this publication, strategies emerged that were particularly useful in building teams. The evaluators' findings included

1) Teams had the best success in **promoting collaboration** when they did the following:
    - Had a goal or specific focus. For example, Kentucky's performance event provided a focus for its team. The Seattle Team briefly floundered until it found a focus in their second year;
    - Integrated project activities with district and state initiatives;
    - Addressed personal as well as district, school, and classroom issues;
    - Combined team building and task-oriented activities;
    - Worked through growth cycles together; and
    - Engaged in shared decision making.

2) Strategies most effective in **promoting teacher leadership and teacher professionalism** included team egalitarianism, practice leading meetings, and shared decision making. Many teacher-participants reported that they felt a greater sense of professionalism collaborating as equals with district and university educators.

3) Strategies most effective in **helping teams extend VINE investigations** revolved around promoting risk-taking that included

- mutual support;
- sharing information, resources and materials; and
- positive reinforcement by meeting regularly during the school year.

4) Teachers attributed their **progress in using constructivist strategies** to risk-taking, team support, and positive feedback. Teamwork promoted their impetus to change — trying out new things, sharing failures as well as success.

5) Constructivism as a guiding philosophy had drawbacks as well as positive outcomes. Teams creating their own understandings together led to egalitarianism, risk-taking, and other positive outcomes listed above. There were occasions, however, when constructivism was not effective, such as when team members who were experts on a topic or subject did not or were not able to exert their authority when expediency was needed. For example, a science educator on one team recognized that several teachers had limited science content knowledge and reported feeling powerless to help correct the situation because it would require direct intervention. The team was already operating under time limitations ruling out the possibility of engaging in professional development to increase subject matter content knowledge. **The discussion and buy-in required by constructivism takes a great deal of time.**

What the Evaluators Learned Regarding Changes in Teacher Practice

The evaluators assessed classroom practice using a variety of teacher log measurements that included what teachers were doing, what students were doing, how students were assessed, how lessons were introduced, and what materials were used.*

For virtually every measure, teacher-participants used more "best practice" strategies, as advocated in the National Science Education Standards, than their colleagues. The differences in the two groups are particularly meaningful since the control group (teacher-participants' colleagues) also exhibited many "best practice" techniques. The largest differences in "best practices" used by teacher-participants were that they

- had their students work on more long-term projects;
- engaged their students in more out-of-class activities; and
- used more laboratory equipment.

The **control group tended to emphasize more traditional practices** (such as lectures, recitations, seatwork, and textbook strategies) that if overly used are considered to be less effective. The largest differences in traditional practices used by teacher-participants' colleagues (i.e., control teachers) were that they

- placed more emphasis on learning facts or definitions;
- lectured more;
- had their students complete worksheets more often or do more practice problems in class; and

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** For those wanting more details about the teacher logs, including the instruments used, data charts, analysis procedure, etc., see Hollweg (1997).*

- had their students do more classwork from the assigned textbook, workbooks, and worksheets.

While emphasizing constructivism created positive experiences and promoted "best practice" classroom strategies, teachers struggled with implementing the "minds-on" part of constructivism. This was, in part, due to teachers' expressed understanding of constructivism as "students taking more control over their own learning." Less attention was paid to teachers guiding students in constructing their own understandings from their learning experiences.

What the Evaluators Presented as Their Overall Impressions

The evaluators concluded that the VINE Follow-Through Project had provided an invaluable opportunity to reflect on professional development activities and that **participants developed useful strategies that helped teachers make changes in their classrooms**. The evaluators also noted the following:

1. Progress on two project goals (building the capacity for ongoing change in the participants, and changing the learning experience for students) was apparent.

2. A model of professional development emerged that had shared features in the three school districts involved in the project, yet was tailored to each district.

3. There was active involvement of non-teacher participants. The project acknowledged how important it is for teachers to initiate and follow-through on important classroom changes but that they cannot do it alone.

4. The project continued to try to balance accomplishing tasks and building relationships.

HOW TEACHERS CHANGED AND WHAT HAPPENED IN THEIR CLASSROOMS

Through participation in the VINE Follow-Through Project, classroom teachers grew professionally and changed what they did with their classes. For **a glimpse into a few classrooms**, we have included three vignettes, one from each team. It is important to note that this sample of three is just that — a sampler. Each teacher did something different in his or her classroom to provide students with learning experiences that would enable them to build their skills and develop their conceptual understandings. Visiting with or observing each of the teachers would offer a view of the diverse ways in which they all masterfully individualized their approaches to meet their students' needs. At the same time, many similarities existed, and the teachers themselves recognized that their classroom practices were the result of the entire team's efforts and ideas. In other words, what you see in the vignettes that follow is **the result of the team's collaboration.**

The South Florida Team Presents a Vignette From One of Its Classrooms: Using Wonder-Science to Improve Process Skills

Lynn and her South Florida teammates decide to try to merge a teaching strategy using "Wonder Books" with an emphasis on the district's science process skills. She finds the experience to be as much a learning experience for her as it is for her students as she strives to let the students do their own "wondering" and develop their own questions.

> As a little girl, Lynn was playing in her sandbox when a large crow came and took away the silver spoon with which she had been digging. She ran into the house to tell her grandfather. He explained that the large crow was a jackdaw, and it would take her spoon and give it to someone else. This person would be surprised and wonder from where and whom this spoon had come. From that day on, Lynn has thought of a jackdaw as something that induced wonder . . . .

After having taught for fourteen years, Lynn felt confident in her science teaching. She used hands-on science experiences on a daily basis with her fourth graders, and had been working to integrate science with math, language arts, and social studies. Nonetheless, Lynn was perplexed about how parent and high school volunteers in the Broward County Audubon Society's VINE Program managed to **get even greater student engagement** in science than she did. She had been observing the lessons trying to understand what it was that these volunteers were doing.

Toward the end of the school year, the local VINE coordinator asked Lynn if she would like to become involved in the VINE Follow-Through Project. Lynn accepted with enthusiasm, hoping that participating in this project would help her understand how these volunteers elicited such student engagement. She also hoped this project would allow her to do more with her students outdoors and **provide greater opportunities to integrate science** with math, language arts, and social studies.

At the 1995 VINE Follow-Through Summer Institute held in Seattle, Lynn and several of her teammates became captivated by the **"wonder" concept**. They liked the "Wonder Books" in which the Seattle Team's students responded to questions such as the following related to the outdoor investigations *Plant Hunt* (1979) and *Seed Dispersal* (1980) from the OBIS series:

> What do you wonder about plant leaves?
> What do you wonder about seeds?

The Wonder Concept and KWL

Upon returning home, Lynn and her Follow-Through teammates were excited about using the wonder concept. The Broward County Schools were emphasizing science process skills. So, in their planning meetings, the team decided to **focus on the science process skills** in each of the outdoor investigations that would be led by volunteers during the school year. Since most of the outdoor activities could be introduced with some sort of wonder question, and because most of the team members usually used the KWL (what students KNOW, what students WANT to know, and what students LEARNED) strategy to introduce a new concept/topic, the team decided to integrate the wonder concept into the KWL strategy. Instead of asking students what they wanted to know, they would be asked what they WONDERED about.

Just before school started that year, Lynn learned that she would no longer be teaching fourth-grade science, but instead would teach a self-contained class of 20 fourth graders considered to be "at-risk" due to low test scores or social-emotional problems. It was part of the school system's Dropout Prevention Project. These were 20 kids who needed extra help in order to be successful in a school environment.

Lynn began the year excited about bringing wonder-science to these children, but quickly found that **they did not seem to know how to wonder**. She was preparing them for a volunteer visit during which the children would be doing *Envirolopes* (OBIS, 1980) as a means of learning about the diversity of natural and man-made things found in the schoolyard. Much of this activity focused on the **process skill of classification**, so Lynn wanted to prepare her students for success in sorting and grouping. Of course, she also wanted to encourage the children to wonder.

This series of learning experiences addresses the NSES Content Standards:

Content Standard A: Science as Inquiry
Students develop

- **abilities necessary to do scientific inquiry.**

Content Standard B: Physical Science
Students develop an understanding of

- **properties of objects and materials.**

Content Standard E: Science and Technology
Students develop

- **abilities to distinguish between natural objects and objects made by humans.**

For the first activity, Lynn placed a variety of buttons on each student group's table. When they came into the room, Lynn asked, "I wonder what we could do with these buttons?" The groups spontaneously began to discuss what they could do with the buttons and carry out their ideas. One group sorted the buttons by color. Other groups sorted by shape and size. A final group made a picture of a flower with the buttons.

Lynn now asked the students why they put them into the groups in the way that they did—what rule did they use to determine which buttons went into which groups? The students began sharing their ideas. As the color, size, and shape groups shared their responses, Lynn noticed that the students who had made a picture were busy regrouping their buttons by color. This group of students had come to the conclusion that they were not "right" to do what they had done, although Lynn had never said anything about their creative way of "doing something" with the buttons.

Lynn felt that the button activity provided a **non-threatening first activity with classifying**. The students all seemed to understand what it meant to group and regroup, and how the qualities of just one thing can make it part of many different groupings. She felt confident that the students could experience success with other types of classification activities.

So Lynn **extended the activity** and asked, "I wonder what other things we could classify?" The students responded enthusiastically with a myriad of ideas as the day progressed. Initially, some students wanted to classify the M & Ms left over from Halloween. Other students wanted to classify themselves. This became a very popular activity, as students would determine classification rules and run to the corner of the room where others with that particular attribute were standing. One corner would be all children with jeans, with another corner for those with skirts. Many other attributes were selected, including hair and eye color and types of shoes being worn. Later in the day during a spelling lesson, a child suggested that they could classify this week's spelling words—those with long *a*, long *e*, *ing* words, and non-*ing* words. During language arts, the students said they could classify their sentence types—statements, exclamations, commands, and questions. Lynn felt confident that her students could now be successful if asked to classify. Next, she knew she needed to work on helping her students "wonder" more.

Overcoming Restraints to "Wonder"

It was the day before the volunteers would come to do the *Envirolopes* activity. Lynn knew that her students would be asked to classify many items that could be found out in the schoolyard. She decided to put out the jackdaw for her students by asking them **what they wondered** they would find in the schoolyard the next day. Lynn was very disappointed, finding that the students didn't seem to know what to wonder about what they might find. So, Lynn took them outside to see what was there. She encouraged them to notice everything, including rocks, leaves, trash, plants, animals— whatever they saw. The children enjoyed this outdoor noticing, but Lynn wasn't sure whether her students were prepared for the next day's *Envirolopes* activity. Her students would be mixed with "regular" classes of students.

Lynn's outdoor jackdaw session paid off handsomely. The parent volunteers reported that her students had come up with some of the most original questions about what could be found in the schoolyard. Not only that, her class had not had any of the discipline problems that often occurred when they were integrated with other classes. Lynn had discovered that **wondering was much easier for her children once they were outside**. Wondering was not instigated by words and phrases on chart paper — the typical mode for beginning the KWL strategy. The outdoors seemed to ignite her students' inherent, yet dormant, desire to wonder.

"...for students, schooling must be a time of curiosity, exploration, and inquiry, and memorizing information must be subordinated to learning how to find information to solve real problems. Adult modeling and environmental conditions play a significant role in the development of students' dispositions to be self-initiating problem posers and problem solvers." Brooks and Brooks (1993: 9)

Lynn felt that her initial work with the students to build their conceptual understanding about classification had worked. Not only had her students learned to classify, they had been more successful than the normally successful students! Additionally, Lynn's encouragement to wonder had led her students to be some of the best questioners during the activity.

Lynn's experience with her students' reluctance to wonder wasn't a one-time event. Over time, Lynn came to realize that her students lacked the ability to be spontaneous thinkers — wonderers. She came to understand that this was because **her students did not want to risk looking stupid**. This was made clear the day one of her students asked, "Can a question be wrong?" The children's prior experiences had led them to associate wondering with being put-down, embarrassed, or wrong. Lynn realized that she would have to work hard at pro-

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viding experiences that would establish an environment in which the children could trust that asking questions — wondering — would be safe.

Trying to teach the children how to wonder became a learning experience for Lynn as well. She discovered that **the children's wonder problem was partly her problem**. Lynn found it difficult to let the children do the wondering. She had thought of herself as a good science teacher because her children did hands-on activities and experiments every day. Now Lynn came to realize that she had done all of the work of learning. She had set out all of the materials, provided a "cookbook" list of directions, and asked the children to do the activities. She had done all of the wondering for them. She realized that she needed to let out the jackdaw for her students — provide the wonder prompt — and let the students take the lead.

The Effects of the Jackdaw on Teacher and Students

In a safe environment where students are encouraged to wonder, their natural curiosity returned and they assumed ownership of their learning.

It was hard for Lynn to let go of her tried and true directive methods of teaching science. Even as she would ask a question, she would find herself starting the wondering. And when the children would wonder, she would catch herself extending the process. She just couldn't seem to let the children wonder for themselves. Lynn realized that she wasn't allowing her students to have ownership of their wonders. As she was able to **become less directive**, she found that their natural curiosity returned and they assumed ownership for their learning. This was success, but Lynn admitted a frustration because once they started wondering, they never stopped. She now existed in a classroom full of constant wonderers.

According to Lynn, "you can't get conceptual development from a child until you get the child to acknowledge that he/she has a question. The students have to realize that they don't know something." Perhaps this is best exemplified by one of her student's remarks at the end of the year. Lynn had collected some leaves from the school grounds and placed them on the students' tables. Each leaf had some area that had been chewed or mutilated in some way. When the students came into class that day, one girl said, "And I suppose you want us to wonder about these leaves?"

And that's what happened. Some children wondered if a bug had chewed the leaves, while others thought it might have been a worm. Still others thought it might have just been caused by the wind. Lynn now took them outside to look for evidence of their hypotheses. While looking for evidence and seeking answers to their original wonders, the children began to wonder about their wonders.

Later in the year, Lynn had the students **create a Wonder Book of their own questions**. Students would write their questions on one side of the page and then write their answers on the other side. For example, one girl wondered why it always rained on her birthday. After doing some research, she found out that her birthday occurred during the middle of hurricane season.

Perhaps one of Lynn's most precious memories regarding her students' progress in wondering came on a day that she wasn't even there! The volunteers had come to do an activity on a day that Lynn was absent. Her students wrote her the letter shown here.

Dear Mrs. A,

There's only rolly
polies and spiders
on our playground.
Why aren't there
more kinds of
animals out there?

Your Class

The jackdaw was at work — instigating wonder in children and enticing them to engage in the initial stages of inquiry. Lynn's own wonder about why the VINE volunteers were so successful with her students had led her on a journey of personal and professional growth. **She had learned to let go** of the jackdaw. The silver spoon was now on the students' tables, in their schoolyard, and wherever they might find themselves in the future.

The Kentucky Team Presents a Vignette From One of Its Classrooms: Integrating Classroom Learning, Outdoor Investigations, and Assessment

In Kentucky, Sharon's fourth graders choose to be in one of three working groups and develop their expertise in a specific area. This story describes the work of one group as it explores worms and their schoolyard habitats. Sharon's teaching strategies include using the KWL (Know, Want to know, Learn) sequence, having students develop and find answers to their own questions, design their own experiments, collect and analyze data, and facilitate the learning of other students. This vignette describes how she assessed and promoted her students' growth, first as learners and then as facilitators of other students' learning.

After teaching primary grades for twenty-seven years, Sharon was assigned a fourth-grade class for the first time – and she had been assigned as the team science teacher. Her lack of self-confidence in science was only intensified by pressures from the building and district level to increase science scores on Kentucky's performance assessments. Therefore, she eagerly volunteered to participate in the VINE Follow-Through Project. The project would incorporate welcomed assistance from parents and other volunteers, and she would learn more about environmental science in an outdoor setting. It would also provide her with support from other educators throughout the year: two teachers at her own school, another teaching team from a school across town, the district science specialist, the district environmental education specialist, and a university professor. And to top it all off, she would use the outdoors as her classroom – a personal favorite.

After several meetings during the late summer and early part of the school year, the Follow-Through team had decided to use three outdoor investigation activities in the spring to facilitate students' understanding of the environmental fac-

This series of learning experiences addresses the NSES Content Standards:

Content Standard A: Science as Inquiry
Students develop
- **abilities necessary to do scientific inquiry.**

Content Standard C: Life Science
Students develop an understanding of
- **the characteristics of organisms.**
- **organisms and environments.**

Content Standard G: History and Nature of Science
Students develop an understanding of
- **science as a human endeavor.**

tors that influence plants and animals: *Worm Worlds* (Berkowitz and Bohlen, 1996), *Animal Diversity* (OBIS, 1982), and *Terrestrial Hi-Lo Hunt* (OBIS, 1979). The resulting unit would **culminate with a performance event and assessment**. The children would choose to work in one of three groups: worms, animal diversity, or hunting for Hi's and Lo's. Each group would develop expertise in one of the investigations and share its expertise with other students when the schools visited one another's sites in May. Parents and high school students would assist teachers during the initial learning experiences and during the site visits. The children would ultimately work together to collect data on animals, habitats, and environmental factors (such as moisture, temperature and light) at each school. As an assessment of their learning, they would draw conclusions about ecological relationships when responding to a writing prompt.

Launching the Project

Sharon first contacted parents who would facilitate the investigations with the student groups and gathered other resources for the groups to use. A fellow team member provided a collection of earthworm activities, and the environmental education coordinator trained the parent and high school volunteers in *Worm Worlds*, *Animal Diversity*, and *Terrestrial Hi-Lo Hunt*. It was now time to **introduce the children** to the project.

Sharon began by explaining to the children that they would choose an area in which they would develop expertise, work on learning as much as they could about their area, and then become the teachers when the other school visited them. The children were excited about becoming "experts" and teachers, and eagerly selected an area of focus. At this point, Sharon worked separately with each of the three groups on the first two parts of the **KWL strategy**: to find out what the children already KNOW and what they WANT to know. She would assess what the children had LEARNED later on.

The eight children who had chosen to become worm experts had some interesting comments regarding **what they "knew"**:

> A worm's tail grows back if you cut it off.
>
> They live underground.
>
> They are easy to catch because they're slow.
>
> There are many kinds of worms.
>
> They don't have a mouth or eyes.
>
> They have many hearts.
>
> They live under rocks.
>
> They wiggle when they move—not in a straight line.

Once Sharon had determined what they already knew — or thought they knew — it was time to find out **what the students wanted to know** about worms. The discussion about what was "known" had prompted some disagreement, and children now wanted to find out what was or was not true about worms:

How do they eat if they don't have a mouth?

What do they eat?

Why do they come out after it rains?

Do they live in all states, or just in Kentucky?

How do they reproduce?

Can they sense danger? (The children had just studied camouflage.)

How do they protect themselves?

Can they see?

How long do they live?

How do they know where they're going in the dark underground?

Seeking Answers

Sharon told the children that they must **find answers to these questions** and many more because the other students would expect the experts to know the answers. She asked the students how they could find their answers. Children suggested using the library and encyclopedias, doing experiments, and observing worms.

Sharon asked the students to select the question that most interested them and then **work in small groups** to find answers. One group chose to observe a worm to find out whether or not it had a mouth. With a hand lens, they could see a mouth, but there was no evidence of an eye. Another group that had chosen to go to the library to do research on worms came back and shared their finding that worms did not have eyes but could detect light.

While looking through some of Sharon's materials, one group found an experiment about whether worms prefer moist or dry places. The children decided to try this experiment because it might explain why earthworms come up after a rain. Sharon first encouraged them to talk about how they would go about doing the experiment. After they had brainstormed and come up with a procedure closely resembling the actual experiment, Sharon let them use the handout and the children followed the directions for the experiment. They charted the results. It appeared that the worms preferred moister places...but why? Once again, a library research group assisted their understanding.

"I have spent less time in direct instruction with my whole class. I'm giving my students more freedom to choose and responsibility in directing their own efforts... I'm nervous with it, but the students are loving it."

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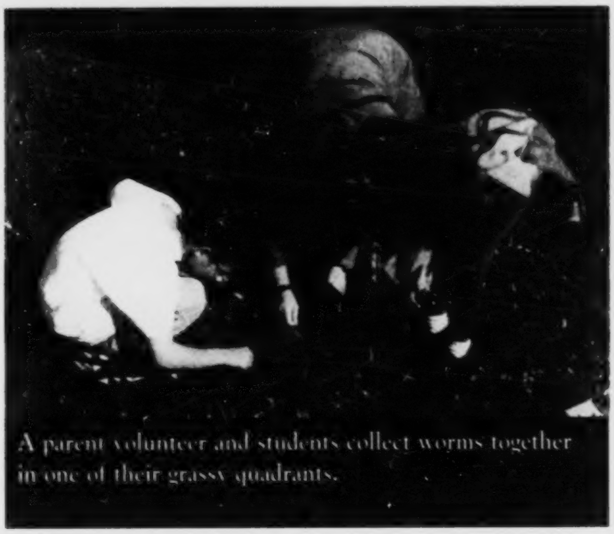
Sharing Findings and Investigating Outdoors

After each group had come to some conclusions, they shared their findings. Now Sharon felt the children were ready to go outdoors for **the Worm Worlds investigation**. Their goal was to find out where the most worms lived in the schoolyard and which environmental factors seemed to affect where the worms lived. Sharon called the parent volunteers to come in and explain the investigation to groups from her class and her Follow-Through team teacher's class. The next day, the volunteers returned to do *Worm Worlds* with the students. Students **recorded data** about the location and environmental factors at sites in the woods and on the grassy playing field. They marked off quadrants in wooded and grassy sites around the schoolyard, poured a solution made with dry mustard over the quadrants, and waited for the worms to appear. They recorded how many juvenile and adult worms they found at each site and **discovered** that the woods had the most worms.


A parent volunteer and students collect worms together in one of their grassy quadrants.

The *Worm Worlds* data sheet indicated that a "clitellum" differentiated adult worms from juveniles. The students **wondered** what a clitellum was, and Sharon encouraged them to research the answer. They found out that it was related to reproduction and, much to their surprise, that worms were both male and female all at once! They also wondered why they had found so many more juvenile than adult worms. Finally, they wondered why the mustard solution used in *Worm Worlds* made the worms come to the surface.* They would find this out sometime, but for now it was time to focus on what they knew about worms and why worms live where they do.

Sharon decided that the children had the knowledge and experience to **practice being teachers**. With the help of parent volunteers, they taught a third-grade class about worms. When they were done, Sharon asked her students to **reflect upon the experience** in their science journals: what went well, what didn't go well, and what they needed to improve. Their reflections indicated that the experiment went quite well, but they had concerns about the behavior of their "students." Some hadn't been paying attention. Sharon asked her students what they should do differently. The children decided that part of the problem was that they, as teachers, hadn't been cooperative in sharing the teaching role. They wanted to think about how they could take turns being the teacher.

Assessing the Learning

Sharon **assessed** what the children had learned **by use of a writing prompt** asking what they had learned and experienced in the *Worm Worlds* activity. She was pleased with the responses, believing that the children had learned a great deal about worms and about the importance of using scientific procedures. Students wrote very specific experimental procedure descriptions as well as their conclusions about why worms live where they do:

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* *Worm scientists developed the technique described in* Worm Worlds *to extract worms from the ground without harming the worms or destroying their habitat. The mustard and water mixture recommended is a very mild irritant that oxidizes rapidly. Rinsing collected worms in fresh water ends the reaction.*

> More worms live in the woods because the soil is looser and easier to burrow through.
>
> More worms live in the woods because there is more decaying matter and leaves. It is easier to find something to eat.
>
> The leaves in the woods hold the moisture in the ground. The worms like the moisture.
>
> The worms like the woods better because there is more camouflage there. It is harder for birds to find them.
>
> Worms don't like the grass because it is too sunny and they would dry out.
>
> The grassy ground is too hard for the worms to build their homes in.

"We are all responsible for our own learning. The teacher's responsibility is to create educational environments that permit students to assume the responsibility that is rightfully and naturally theirs. Teachers do this by encouraging self-initiated inquiry, providing the materials and supplies appropriate for the learning tasks, and sensitively mediating teacher/student and student/student interactions." Brooks and Brooks (1993: 49)

The children had learned much through Sharon's **facilitation of their conceptual development**. She had started with what they knew (or thought they knew), encouraged inquiry by finding out what they wondered about, and provided a learning environment that supported their investigations. The worm experts were now ready to be teachers when the students from the other school came to visit. In return, they would learn about animal diversity or environmental conditions from their peers at this other school. Ultimately, they would interact with other "experts" in their class in order to learn about the discoveries made by all of the groups and further develop their concepts about how environmental factors influence living things.

The Seattle Team Presents a Vignette From One of Its Classrooms: Developing Students' Understandings and Abilities Over Several Months

In Seattle, Brian uses a series of worm activities and inquiries to develop the concept of habitats with his students. His goal is to have the students build on their learning over time. Brian's teaching strategies include assessments of student understandings, the development of a "Worm Hotel," the use of books plus students' questions and observations, writing assignments, and, as in South Florida and Kentucky, outdoor investigations.

Brian had been teaching third grade at his school for three years when another teacher approached him about getting involved in Seattle's VINE Program. Brian had already observed some of the VINE sessions that parent volunteers had done with other classes and had overheard several children talking about how much fun VINE was. He was interested in learning more.

Brian's coworker also explained the VINE Follow-Through Project to develop activities that could be done by the classroom teacher before and after the volunteers came to do an outdoor activity. Brian liked the idea of being involved in the creation of a model for other teachers that would integrate outdoor activities with classroom teaching. He also liked the Follow-Through Project's emphasis on constructivism.

Volunteers were already scheduled to do eight outdoor activities during the upcoming year, and the Seattle Follow-Through Team met to plan lead-in and follow-through lessons for each of the eight activities. The team had planned some pre- and post-activities regarding populations for the spring, but Brian also wanted the students to develop their conceptual understandings of habitats throughout the school year. He wanted to integrate the activities that the parent volunteers would be doing with a habitat focus. Brian felt that three of the spring outdoor lessons would be particularly helpful in developing habitat concepts: *Worm Worlds, Terrestrial Hi-Lo Hunt*, and *Roots and Shoots* (OBIS, 1982).

Launching a Year-Long Inquiry

To develop these concepts throughout the school year, Brian wanted to build a "Worm Hotel" in his classroom. A Worm Hotel would provide an excellent, **ongoing way for the students to develop their concepts** regarding worms, plants, environmental factors, and how each was connected in a worm habitat.

At the beginning of the school year, he brought in two aquaria — one of which was quite narrow and had a crack. Brian asked what the students thought could be kept in the cracked aquarium. Several children suggested ants, but after some discussion regarding the lack of ant populations in the Seattle area, another child suggested worms. Perfect! Although Brian had wanted to build the Worm Hotel, he had no intention of doing anything the kids didn't really want to do. Brian began to guide them to wonder about how to keep worms alive — the perfect way to get them immersed in inquiry regarding worm habitats.

Brian began by holding a brainstorming session about what would be needed for the worms' habitat. He first asked the children what a habitat was. The students seemed to have a lot of **prior knowledge** about habitats, stating that a habitat was where an animal lived, hid from enemies, and found its food. Brian asked the children what kind of habitat the kids thought would be needed for worms — in what surroundings would the worms be happy? This was something the kids weren't as sure about. They suggested that soil would be needed and that the worms would need something to eat — but they weren't sure what. Brian took this opportunity to introduce the concept of decomposition. He wrote the word "decomposer" on the board and asked if anyone knew what it meant. Most of the class had no idea, but one girl responded, "That's something that eats other things — like worms that eat leaves and the leaves turn into little pieces and then the plants can be healthy." Now many children in the class nodded their heads to agree. Brian felt that most of the children knew the

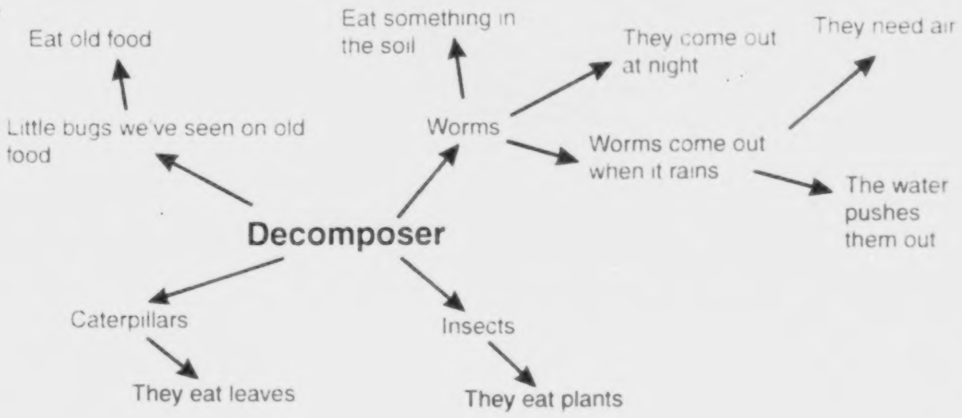
This series of learning experiences addresses the NSES Content Standards:

Content Standard A: Science as Inquiry
Students develop
- **abilities necessary to do scientific inquiry.**

Content Standard C: Life Science
Students develop understanding of
- **the characteristics of organisms.**
- **life cycles of organisms.**
- **organisms and environments**

Content Standard G: History and Nature of Science
Students develop understanding of
- **science as a human endeavor.**

concept, they just didn't know its name. Brian asked the students what decomposers they were familiar with. Brian wrote their responses on the board, linking them together in the form of a **concept map or web, as shown below.** When a child suggested a decomposer, Brian would ask what it decomposed. One child's response would often trigger another, as shown.


Eat old food
Eat something in the soil
They come out at night
They need air
Little bugs we've seen on old food
Worms
Worms come out when it rains
The water pushes them out
Decomposer
Caterpillars
Insects
They eat leaves
They eat plants

Many of the comments prompted discussions about worm habitats: What do worms eat? Why do they come out when it rains? The discussion had brought up some concepts that children would later want to investigate. For now, though, it appeared that the children thought that worms were decomposers that ate something in the soil. Not only were the students struggling with what the worms needed in their habitat, but also with the idea that worms help create their own habitat.

Creating a Habitat

Brian had **a book about building worm habitats**, and he invited the children to gather around as he read it and showed the pictures. The book indicated that soil should be layered with leaves and that the worms would eat the leaves and turn them into more soil. The kids were glad to find out that worms eat leaves, but they were really intrigued with the idea that worms could turn leaves into soil. They also wanted to see the tunnels mentioned in the book.

Brian asked the students where they thought that worms could be found in the schoolyard. Several suggested that they had seen worms under rocks before. Others weren't sure. So, Brian took the kids out on **a worm hunt**. They found that more worms seemed to be under trees with lots of leaves. They also found worms in grassy areas, but there seemed to be more worms in areas that were more moist and less sandy. Based on what they had observed in the schoolyard and learned from the book, the students were now ready to build the Worm Hotel.

Brian sent the children out into the schoolyard to **collect items** for the worm habitat: soil, worms, other creatures they thought might be decomposers, and leaves. They followed the directions in the book to **build the Worm Hotel**. It was open for business — and student inquiry.

Curiosity Increases

The kids' curiosity didn't stop. They **wanted to find out much more**. The discussion about worms coming out when it rained, initiated during the concept mapping activity, made some children want to **pour water** into the Worm Hotel **to see what happened**. Brian explained that there was no place for the water to go in an aquarium habitat, as there would be in a worm's natural habitat. The children decided to pour just one cup of water in one place so they could see what the worms did. As the students watched the tunnels become filled with water, they suggested that the worms would drown or suffocate. Their questions also led them to conduct experiments about the effects of moisture and light on the worms, their preferences for food, and the presence of other organisms.

Observations of worms and inquiries about their habits continued throughout the year.

Another phenomenon also intrigued the students. Over time, several volunteer seedlings had sprouted. The children **noticed the roots growing** right next to the glass sides of the aquarium. They also noted that there seemed to be more seedlings on the side of the aquarium that was exposed to light. Brian encouraged them to look at the roots closely. The children noticed little hairs on some roots – Brian knew that the students would be able to use this awareness of roots when they did *Roots and Shoots* with the parent volunteers.

The students **wondered if the worms would eat the roots**. Every day they would watch for evidence. They observed the worms crawling through their tunnels by the roots, but never saw any indication that the worms were actually eating them. After awhile, the seedlings began to die. Students noticed that the dead plants' roots disappeared, and thought that the worms must be decomposing the dead roots and making soil. Brian took this opportunity to share his own experiences about how worms helped his garden by making air tunnels and bringing nutrients to the roots. Brian was pleased that the students had come to realize how important plants could be for the worms. The concept of habitat had grown. No longer was this a simple worm habitat. It was a habitat for plants and other creatures as well. And . . . **all of the inhabitants seemed to be important to the others**.

> **"With curricular activities clustered around broad concepts, students can select their own unique problem-solving approaches and use them as springboards for the construction of new understandings."**
> **Brooks and Brooks (1993: 47)**

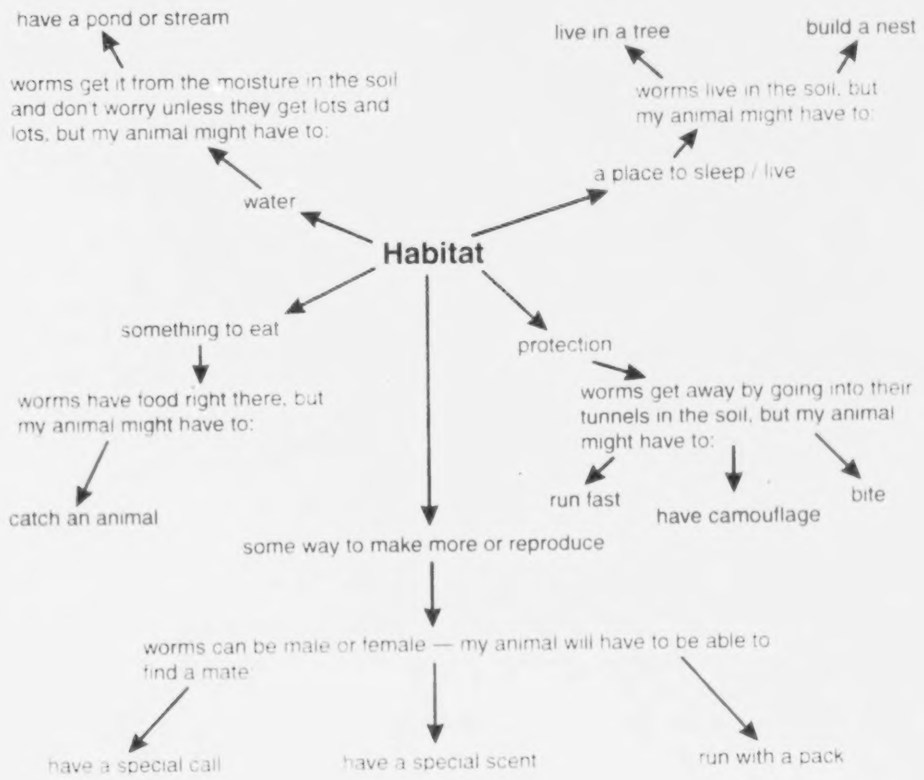
Brian's students continued to observe and do other investigations with the Worm Hotel throughout the winter and into the spring. Brian knew that the parent volunteers would be coming in March and April to do *Worm Worlds*, *Terrestrial Hi-Lo Hunt*, and *Roots and Shoots*. He felt confident that his students knew about how environmental conditions affect a habitat, how worms live in and affect a habitat, and the importance of plants in a soil habitat. Now he would focus more upon the lead-in and follow-through activities that the Seattle Follow-Through Team had worked on and emphasize **populations** in the schoolyard habitats.

Worm Worlds focuses on identifying **which habitat in the schoolyard has the most worms**. When the parent volunteers came to do *Worm Worlds* with Brian's class, the students built on what they had learned with the Worm Hotel. They chose to compare the number of worms in the grassy areas under the trees, where they had found many worms in the fall, with the landscaped areas next to the building. As they poured the water solution over the ground, they talked about being able to visualize what was happening underground as the worms crawled up and out of their tunnels. When they counted the worms, the students were surprised to find about the same number per square meter in both places. They thought that maybe because there were no leaves on the ground, the soil was similar in the two places they had picked. Maybe, they said, there were more worms in the school's ground than they had thought!

The fact that they **hadn't discovered exactly what they expected** outside made them eager to also do *Terrestrial Hi-Lo Hunt* and *Roots and Shoots*. They learned more about how moisture, temperature, wind, and light can be different in sunny and shady areas. When finding different kinds of roots for *Roots and Shoots*, Brian's students were careful as they dug so they could get as many tiny root hairs as possible, and they noticed that there were more of some kinds of weeds in the sunny areas than in the shade.

Assessment through Application

Brian **assessed** what his students had learned about habitats **by observing them during their investigations and through the use of a writing assignment**. Near the end of the school year, Brian asked his students to do a report on how an animal survives in its habitat. In this way, Brian hoped to see how his students applied what they had learned about habitats of worms to other situations. Before the students started working, Brian led another brainstorming session. This time, he started with habitat as the main concept and asked what the most important features of a habitat were in helping an animal survive. Students listed food, water, a place to sleep and live, protection, and the ability to reproduce. He then asked how their worms had survived with each feature listed, and what might be different for the animals they would be writing about. Brian wrote everything they said, although the following brainstormed map or web conveys only a small portion of their discussion:


have a pond or stream
live in a tree
build a nest
worms get it from the moisture in the soil and don't worry unless they get lots and lots, but my animal might have to:
worms live in the soil, but my animal might have to:
a place to sleep / live
water
Habitat
something to eat
protection
worms have food right there, but my animal might have to:
worms get away by going into their tunnels in the soil, but my animal might have to:
catch an animal
run fast
have camouflage
bite
some way to make more or reproduce
worms can be male or female — my animal will have to be able to find a mate
have a special call
have a special scent
run with a pack

Brian felt confident that his students had learned about habitats through their study of worms. Now, they were ready to **apply what they had learned** and to learn even more about how animals interact with their habitats — including the environmental conditions, plants, and other animals that coexist in that habitat.

Starting with what the children knew, or thought they knew, about habitats and worms, Brian provided numerous learning experiences throughout the year that enabled the children to test their existing knowledge and build new knowledge based upon what they observed and did. There was no doubt that his children had experienced conceptual development in a constructivist learning environment. The Worm Hotel seemed to have been an ongoing host for student inquiry regarding interdependence in a soil habitat, and Brian's participation with the Follow-Through Project had provided the initiative to engage his students in finding — and learning about — urban nature.

THE KINDS OF PROFESSIONAL GROWTH THAT RESULTED FOR THE NON-TEACHER TEAM MEMBERS

The VINE Follow-Through Project's most obvious and well documented end-product was the change in teachers' classroom practices, but participants with responsibilities outside the classroom felt strongly about the growth that they had experienced. Team members from universities, school district curriculum and instruction offices, and nonformal education organizations said that the long-term, VINE Follow-Through experience enabled them to grow and develop professionally and personally in several ways. At the July 1996 Summer Institute, they listed these ways.

First, non-classroom teacher team members said they learned:

- to empower team members, **mutual respect** and **trust** must develop;
- to **listen**;
- to **trust group dynamics** and decisions;
- to slow down and be **patient**;

By comparing experiences, non-teacher members of the teams discovered that they had gained many of the same insights and changed in similar ways as they worked with their teams.

- to allow time **to give and receive validation and affirmation**; and
- to really **appreciate an elementary teacher's life**.

Second, these learnings affected how many of them did their work both inside and outside of VINE Follow-Through. On their list of ways they had grown and developed were statements such as:

- I evolved from being a consultant to being a collaborator.
- We didn't expect to experience growth equal to that of the teachers but we did.
- I became comfortable synthesizing/distilling the team's work and was willing to be the spokesperson for decisions developed by the team, even when the decisions were different from my original ideas.
- Within our team, we became friends as well as professional colleagues. I now see that personal and professional relationships must both be developed.
- What we did was not the result of any individual but definitely a team effort.
- Sometimes the task is not always the most important thing. We need to remember to put people first.

The following three personal reflections amplify these points and describe the ways in which VINE Follow-Through resulted in professional growth for three individuals:

- a nonformal educator who felt her expertise and the value of her work were validated by her colleagues;
- a university professor who learned to be a collaborator with, rather than a consultant to, a team of educators; and
- a school district administrator who took on new roles taking risks and changing alongside teachers and other educators on his team.

A NONFORMAL PROGRAM COORDINATOR'S PERSPECTIVE

A Validating Experience

If I had to put my VINE Follow-Through experience into one word it would have to be *validating*.

Nonformal educators and the programs they produce have a lot to offer classroom teachers. But the teachers' curriculum burdens are so heavy that outside programs are often just an add-on or extra. The kids may learn something from the extra experience but they don't have time to use it. Connecting these experiences to what they are already doing in class is an extra stress that requires the creativeness and flexibility of the teacher and adds more to the curriculum burden.

In VINE Follow-Through, the teachers and the nonformal educators worked together to select VINE activities and to plan ways to carry the skills used throughout their curriculum. Without seriously changing either the VINE Program or the classroom curriculum, but working together to find the common elements, the VINE Program became one of the frameworks upon which the teachers built their year's curriculum. VINE explorations were fun, hands-on, and outdoors and involved skills that the students were learning and using regularly in class. The outdoor, small group, and volunteer-led aspects of the program made it a personal and interesting experience, but the practice of skills made it a valid opportunity, valuable enough to take classroom time to do.

Only through our close communication and teamwork approach did the teachers realize how much background and knowledge the nonformal educators had put into these programs and that, through joint planning, these programs could help them with their burdens. When the program has value to the teacher, it is no longer an add-on but an exceptional way to explain by example what they are trying to accomplish. A program that is valid to its constituents makes more sense to operate.

A UNIVERSITY PROFESSOR'S PERSPECTIVE

Moving from "Consultant" to "Collaborator"

University folks are frequently viewed by others – and themselves – as the "experts" called in to advise and consult on various topics. We give a few talks, run a couple of workshops, facilitate some hands-on or minds-on activities, and then we depart. Sometimes I think we view ourselves as "hired guns" who ride in on our white horses to "save" a situation with our magic bullets, do the job, wave good-bye, and ride out of town with a hearty "Hi Ho, Silver, away!" Our long-term commitments and relationships generally do not extend for more than a quarter or a semester with the teachers in our courses or summer institutes. Our lives revolve around our "professional community," composed of other members who ride the same horses that we do. So when I was asked to be the Co-Principal Investigator in VINE Follow-Through, my thought was, "Hey, no problem. I've got the bullets for that job and a white horse to ride in and out on."

Wrong! As the group struggled together – for years – over problems ranging from miscommunications to members being replaced to confusion about the project's goal, I found myself becoming an authentic teammate and the group evolving into a real team. I think the growth of the group into a team astonished all of us as we all learned to trust team dynamics and discovered that we were not able to be effective unless we paid equal or more attention to developing and maintaining relationships as we paid to attending to tasks.

Our team certainly didn't transform itself from a group into a team overnight. We had to learn to trust each other, challenge ideas and not people, be open and honest with one another, respect everyone for his or her areas of expertise, affirm and support one another's ideas and actions, and listen. Together we agonized over the life-threatening illness of a teammate's daughter and rejoiced over the marriage of another teammate's daughter. It was painful; it was exhilarating; and it was an experience that convinced me that I want to be a collaborator who really knows the people with whom I work, not a consultant who rides in and out on a white horse.

A SCHOOL DISTRICT ADMINISTRATOR'S PERSPECTIVE

Observing Professional Growth

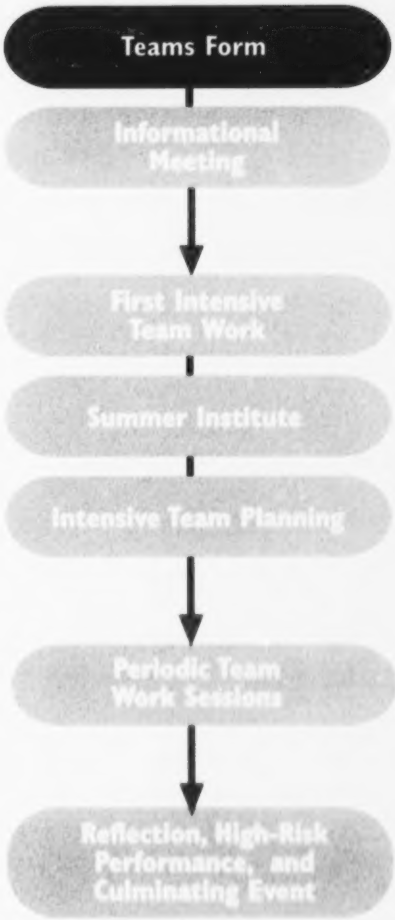
Change is uncomfortable and counters the natural human urge to "put things back the way they are supposed to be." Change requires risk-taking, which is difficult for an individual facing group dynamics – a team seeking change provides the support for individuals to continue the course toward the goal. The team approach however provided challenges to this school administrator as our team sought to go beyond the norm and asked to "bend the rules of the bureaucracy." Can we take extra field trips beyond the district limit? Can we have extra funding to plan? Can we hire more substitute teachers? Will what we are doing fit with the state mandates? Empowering teachers can be threatening to the "system" and to individuals. The team provided the safety net for risk-taking.

The value of being an equal team member bolstered my enthusiasm for asking for special permission to extend the rules, to provide additional funding, and therefore to make this project possible. This enthusiasm for change on my part was because I was part of the team. My initial reservation was that the teachers might be further stressed by the project and I would have to seek ways to make them feel rewarded for their extra duties. The team enthusiasm and support was reward enough.

It is difficult to quantify and describe the professional development experiences we all had as a result of this project. Each of us benefitted in different ways; each of us changed in positive ways as we redefined our roles in terms of constructivism. Team building, trust, responding to challenges, and the freedom to create an instructional event that differed from the standard all played an important role in our professional growth. Our team will go on forever since we continue to create both social and professional reasons for meeting. We recognize that we have a collegial support group that provides constructive criticism for our ideas and offers us new ways of approaching instructional dilemmas and being rewarded by the group.

The phenomenal thing about this project is that as a "non-teacher" on the team, I was fully aware of how the teachers were changing their teaching methods, their planning techniques, their problem solving, and their entire view of instruction – yet they were unaware of the process! I observed how well the team functioned to overcome obstacles, create more work for themselves, and go that extra mile to plan events to benefit their students. We kept saying that the students were always our first consideration – we knew they would learn and be motivated by our project. However, we were unaware that we were also learning and changing along the way! Near the end of the project, when we took time to reflect, I think we realized that all of us are the real learners and that this project will have a long-lasting effect on how we do our work.

What We Did


Teams Form
Informational Meeting
First Intensive Team Work
Summer Institute
Intensive Team Planning
Periodic Team Work Sessions
Reflection, High-Risk Performance, and Culminating Event

You may be reading this because you've decided that a team approach to professional development sounds interesting. Or, after reading the preceding section of this publication, you may want to know what strategies we used to achieve the kinds of outcomes presented. In either case, you may be asking: What did participants do in this project? How did they do it?

In this section, we tell the story of what we did to involve teams of educators in meeting mutually held challenges. We relate our story step by step — starting with how teams formed, moving through one and half years of joint efforts, and concluding with the learnings distilled and shared at our culminating event. We believe there is enough detail here to enable you to get a realistic feel for what happened and to assess whether a similar approach may be appropriate for your situation. If so, this section and the resources in the appendices will give you some concrete ideas for getting started.

HOW TEAMS FORMED

> *How are the human and financial resources needed to address the VINE Follow-Through challenge assembled? What tools and lessons from our experience are available to you? In the next few pages, you will find the story of how one person championed the formation of the South Florida Team. Page 42 summarizes the four elements that this team, as well as the two other VINE Follow-Through teams, found to be most important as they began.*

Karen Mauck, Coordinator of Broward County Audubon Society's VINE Program, had been recruiting and training high school and adult volunteers to lead fourth graders in outdoor investigations for six years. Through the program, more than five thousand children had gone onto their schoolyards in small groups four or five times during the school year. They discovered how many different kinds of plants and animals lived in what they had previously thought of as a flat, monotonous stretch of grass. They found a diverse array of tiny creatures living in the leaves that were piled under bushes and against walls and fences. When they examined the soil more closely, they discovered that the sandy soil actually contained dead plant and animal parts. The volunteers had provided the children with many experiences that otherwise they would not have had. But the experiences seemed to end when the volunteers left.

Karen felt that there was so much potential for more, if only the teachers would build on these experiences with their classes. In a VINE evaluation, she had learned that 83 percent of the teachers wanted to work with other teachers to improve their science program. At annual VINE Network meetings, she had discussed this dilemma with other VINE Program Coordinators and had heard about Seattle's initial efforts. So, when there was an opportunity to gather together a South Florida team and apply to become part of the multi-year VINE Follow-Through Project, she leapt at the chance.

She talked individually with prospective team members from the school district and local university, as suggested on a "who to involve" handout, which she had received through the VINE Network (see pages 37-38.) (You might also find the matrix shown on the next page to be helpful.)

Karen Mauck provided the spark and leadership that brought South Florida's team together.

Karen then organized a lunch meeting at her home. At this first meeting, the district's science curriculum specialist and environmental education coordinator indicated they would be willing to allocate some substitute release days and inservice funds to the effort. However, the project had to meet the district priorities of integrating technology into the curriculum, emphasizing science process skills, and supporting the implementation of the district's fourth-grade science curriculum using an interdisciplinary approach. The university faculty member, based on her work with preservice and inservice courses, had many good ideas. An environmental education leader in the county, one of Karen's professional friends known for her facilitation skills, agreed to take on the responsibility of facilitating and coordinating the team's efforts. The group also discussed the project timeline, budget (in Appendix page D.2), and possible teacher participants. They decided that it was important to recruit teachers who, in addition to being involved in the VINE Program, had leadership qualities or potential, were distributed throughout the district's twenty-two innovation zones, represented socioeconomically diverse schools, and possessed an array of different skills and abilities (from teaching basic skills to using student-centered cooperative groups).

Continued on page 41

TEAM BUILDING TIP

Teams need catalysts. Initially, someone has to be the "champion" to begin connecting people together, recruiting others to help, sharing passion and ideas for the proposed project. Besides "champions," team members play various roles. *See Appendix page G.1 for a list of those roles.*

Who To Involve — for Nonformal Educators forming a Follow-Through Team

Who should I talk with to get started?

Two people are essential for the formation of your team.

- **Your school district's science curriculum coordinator**
  This person may go by a different title (e.g. instructional specialist). No matter what the title, he/she is the person responsible for
    - inservices for elementary science teachers and/or elementary teachers who teach science as well as all other subjects.
    - distribution and administration of the school district's Eisenhower Funds for professional development in science.
    - elementary science curriculum standards, curriculum guides, and instructional materials for your district.

  In other words, he/she knows what science content and processes teachers are expected to teach in your districts' elementary schools, and is expected to provide the training and support needed for them to do that. If your district has both elementary and secondary science specialists, you may want to initially meet with both of them. The elementary teachers and principals that you work with should be able to lead you to the right person(s) if you do not already know who they are.

- **An elementary science educator of stature who is actively involved in science education reform** (e.g. a professor or leader from a post-secondary institution)
  Among the most important qualities in this person are:
    - a solid track record showing the ability to acquire grant funding, conduct teacher inservice courses and support teachers in changing classroom practices.
    - thorough understanding of current science education reform initiatives and practices including National Science Education Standards, constructivism, reflective practices, alternative assessment.
    - either a background in the science of ecology or colleagues who can provide that background to the team.
    - time and interest in working with a team of people from your school district and project for at least the next 2 years.

  The school district's science coordinator may be able to point you to a person with these qualities who he/she has worked with before.

NOTE: Since these two as well as the other team members must all work together, it is important that they all respect and can get along with one another.

Who else will be part of the team?

In addition to you (i.e. your project's leader) and the two people listed above, your Follow-Through Leadership Team will include **5 classroom teachers**. We expect you to select teachers for your team who:

- have involved their students in your program's hands-on learning experiences for at least one year.
- are interested in restructuring their classroom science curriculum to provide students

Continued from previous page

with more inquiry opportunities following the volunteer-led outdoor investigations.

- are willing to experiment/take risks and work on innovation as a part of a team.
- use a variety of classroom management and teaching techniques (such as those listed at the top of the Teacher Application Form).
- possess leadership traits necessary to successfully conduct inservice courses and peer-coach other teachers.

We expect at least 3 teachers will be science advocates; 1 or 2 may be science shy.

The "9th slot" on each team will be negotiated with each city by the project director. This person will bring to the team one or some combination of the following strengths, in which the team is otherwise deficient:

- an ecologist, familiar with current ecological research and concepts, will guide the team in identifying ecological themes/concepts for students to pursue and help guide teachers and students in framing questions and/or designing their follow-through experiments.
- a graduate student with experience in ecology and/or science or environmental education who can visit classrooms, facilitate communication and functioning of the team, and assist the science education professor or school district science specialist in "chairing" the team.
- a science educator familiar with reflective practice and educational reform initiatives who will guide the team in assessing their work, planning, and moving towards agreed upon goals. (This person may bring different areas of educational expertise to the team and, most importantly, will have time to take on an organizing and lead role for the team.)

Other considerations in selecting your team?

People from diverse backgrounds bring a richness of ideas, skills and perceptions to a group. In selecting your team look for diversity in culture/race, gender, teaching strengths (inculde both science-shy and science-advocate teachers), learning styes, and personality types. But be sure that all team members are committed to working with the team to build on your program and improve learning opportunities for children over the next 2 years.

While we expect each team to be made up of "leaders" and to make plans and decisions by consensus, each team must designate a primary contact/facilitator. This person will be responsible for keeping the team on track and serving as the key contact with NAAEE's project director/P.I. of the NSF grant. Be sure that your team has a clear understanding of who will serve in this role prior to defining your "9th slot" and developing your budget so that the needed resources can be allocated to this end.

TEAM BUILDING TIP

Build the team consciously. Talk to a few individuals first to see if there is interest in the proposed idea, to obtain support, and to begin to identify key people and resources.

	Pat	Rose-Marie	Joyce	Karen	Patty	Lynn	Joan & Brenda	Karen	Barb	Total ✓'s
➡ Has access to/can acquire **money*** to pay for salary of: University faculty			✓							1
School district curriculum specialist	✓	✓								2
Nonformal education / community resource person		?								1?
Team coordinator										
Teachers' substitutes Saturday/hourly pay Summertime pay	✓ ✓	✓ ✓			through Principals					6
➡ Thoroughly understands the **nonformal education** or **community resource** being used: Has used program for one or more years				✓	✓	✓	✓	✓		5
Can influence content and/or affect delivery				✓						1
➡ Knows **district's elementary science curriculum and materials**: Has used curriculum and materials in an inservice setting		✓			✓					2
Has used curriculum and materials in a classroom setting					✓	✓	✓	✓		4
Knows how to use and affect changes in district's support of/for these (e.g. materials, inservice training, technology/computer access, buses or other support needed)	✓	✓								
➡ Has planned and delivered **professional growth programs:** Can acquire credit (university and/or inservice credit)	✓	✓	✓							
Knows and practices most effective educational change strategies and what's known from teaching/learning research										
Has experience working in teams of professionals										
➡ Understands thoroughly and has experience implementing national, state and district-level **standards, mandates, frameworks, priorities,** esp. regarding:										
Concepts and processes students are expected to understand/develop										
Teaching strategies/practices										
Assessment practices and policies										
Program quality and conditions										
Support and resources needed for imple										
Ability to obtain district-level										
➡ **Has strong scienc**										
Understandin										
Working k understar										

For a complete copy of this matrix, see Appendix B.1 and B.2

* ".

The South Florida Team (L to R)

Lynn- Teaches "hands on" elementary science to fourth graders; mentor teacher.

Karin- Teaches students from low-income neighborhoods; fourth- and fifth-grade team leader.

Barb- Nonformal environmental educator and facilitator.

Karen- Local VINE Program coordinator.

Pat- District's environmental education coordinator.

Brenda- Newly certified fourth-grade teacher.

Rose-Marie- Responsible for Eisenhower-funded professional development and elementary science curriculum.

Patty- Teaches fourth grade; inservice facilitator.

Joan- Teacher-"coach" for student-centered fourth-grade classroom.

Joyce- Teaches elementary science and environmental education at local university.

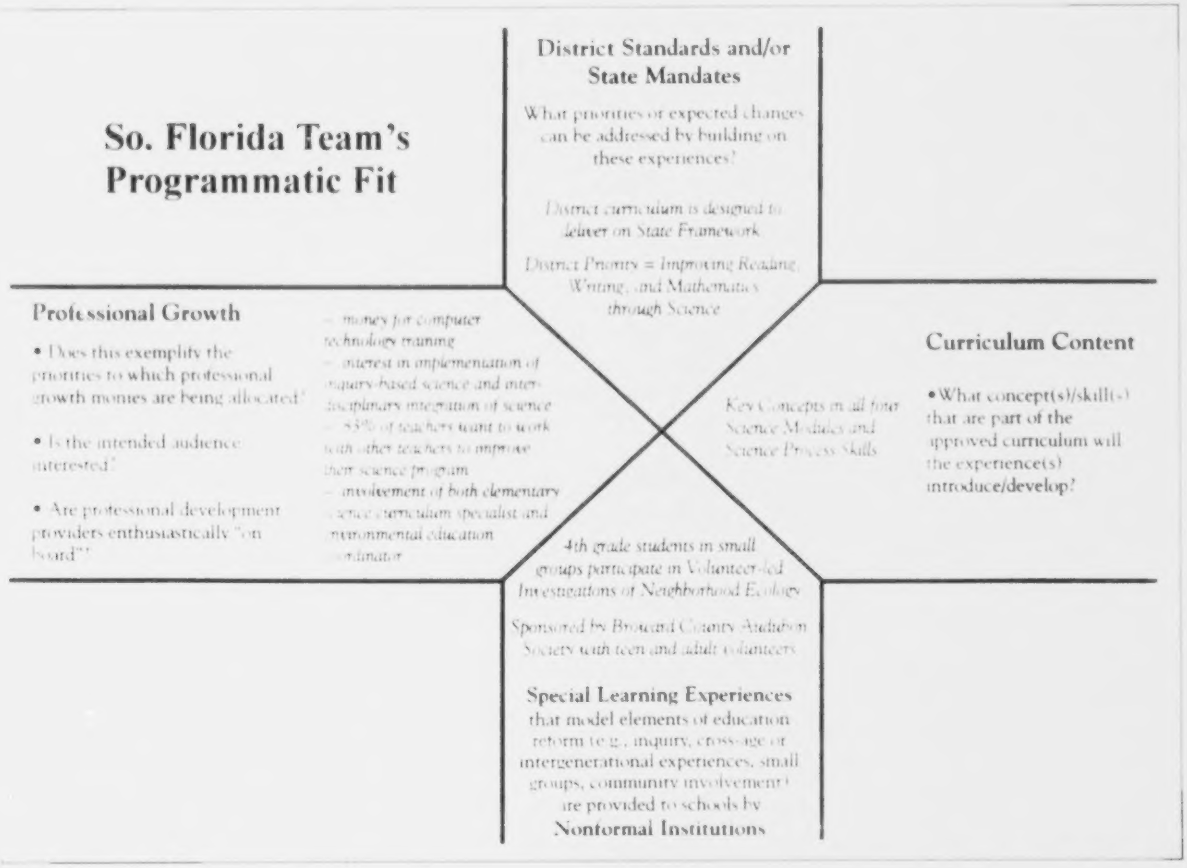
Continued from page 36

Karen led the group in recruiting classroom teachers and completing the team's VINE application (Appendix pages D.1-D.5). Everyone pitched in filling out individual forms and taking responsibility for getting various approvals from deans, superintendents, the school board, and principals. The South Florida Team's application was approved by NAAEE's Project Director, and the team gained access to NSF grant funds starting in the spring of 1995. Those funds, plus district and building-level professional development funds and regularly salaried work days, enabled all team members to get paid for their work on this project and cover the costs of travel to VINE Follow-Through Summer Institutes.

Through a series of getting-acquainted sessions and phone calls, the team began identifying some important interlocking aspects that focused their work. As the diagram below shows, the focus was multi-faceted, and each facet dovetailed with the others. It gained strength and support by including increased use of technology/computers; links to key concepts in the fourth-grade science units; and an interdisciplinary approach aimed at improving reading, writing, and mathematics through science, as well as an emphasis on the science process skills.

RED FLAG!

There must be a good fit between the program being proposed and existing priorities of the organizations involved. Without the fit, it will be difficult to obtain needed resources and support.



So. Florida Team's Programmatic Fit

District Standards and/or State Mandates

What priorities or expected changes can be addressed by building on these experiences?

District curriculum is designed to deliver on State Framework

District Priority = Improving Reading, Writing, and Mathematics through Science

Professional Growth

- Does this exemplify the priorities to which professional growth monies are being allocated?
- Is the intended audience interested?
- Are professional development providers enthusiastically "on board"?

– monies for computer technology training
– interest in implementation of inquiry-based science and interdisciplinary integration of science
– 55% of teachers want to work with other teachers to improve their science program
– involvement of both elementary science curriculum specialist and environmental education coordinator

Curriculum Content

- What concept(s)/skill(s) that are part of the approved curriculum will the experience(s) introduce/develop?

Key Concepts in all four Science Modules and Science Process Skills

4th grade students in small groups participate in Volunteer-led Investigations of Neighborhood Ecology

Sponsored by Broward County Audubon Society with teen and adult volunteers

Special Learning Experiences that model elements of education reform (e.g., inquiry, cross-age or intergenerational experiences, small groups, community involvement) are provided to schools by **Nonformal Institutions**

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Summary

The VINE Follow-Through professional development teams that formed in Seattle and Louisville came together in a manner quite similar to the team in South Florida.

All three teams shared the following characteristics as they formed:

- **An "initial advocate" or "champion" initiated and guided the team's formation.** This person saw the value of gathering together a team of colleagues to address an authentic problem. In our project, the champions were the educators in charge of recruiting and training the VINE volunteers who led students in schoolyard investigations. They wanted to involve others in building these investigations into the ongoing curriculum and felt strongly that the result of such an effort would increase the value of the VINE program and benefit the children.

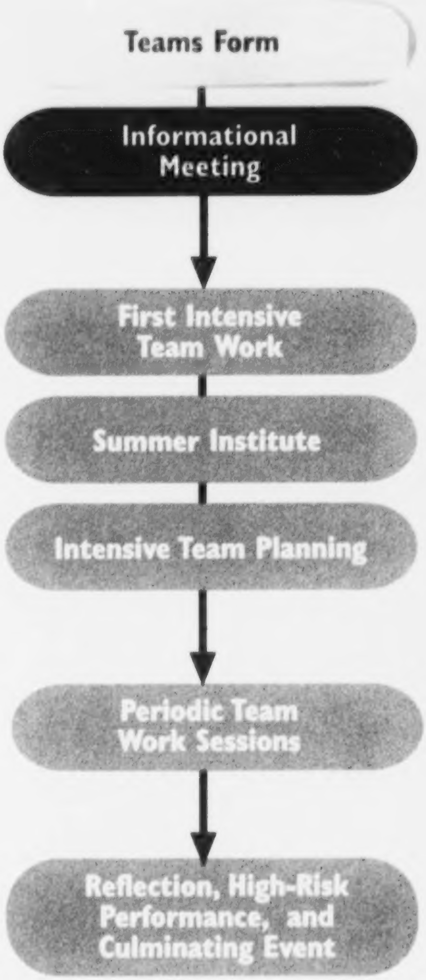
- **People from different roles and places were recruited and brought diverse perspectives and resources to the team.** The university and school district educators brought resources (such as access to grants and Eisenhower/Department of Education funds) and knowledge (such as of ecological concepts, research, and professional development strategies) that were different from the teachers' classroom management skills and interdisciplinary approaches. The nonformal educators added expertise in organizing, facilitating, and using community resources. All of these people readily became active players on the team and their joint efforts created the kind of "programmatic fit" needed to support the team's work. (See pages 37-39 and Appendix pages B.1-3 for our suggestions regarding "Who To Involve," "Amassing Enough Resources," and "Creating a Programmatic Fit.")

- **Initial conversations and meetings were exploratory, open, friendly, and interactive** among **people** who **respected one another's work**, even if they did not know each other. The local VINE Program coordinators invited and gained the participation of teachers, because they had been working with and delivering a valued program to students for one or more years and had earned the trust of the teachers and their principals. On the other hand, university and school district participants had in many cases not worked previously with the person who recruited them, but got involved based on the reputation of that person and on a desire to work on a worthwhile challenge. From the beginning, everyone felt comfortable getting to know the others as fellow professionals, and all felt they had a part in shaping the project and its products.

- **Printed information supplemented the verbal exchanges** and described the nature of the project, the timeline, and the benefits and responsibilities of participation. We used a combination of text, diagrams, and application forms, which had to be completed and signed. (See Appendix pages A.1, C.1, and D.1-5.) Different vehicles worked for different people. But as the project progressed, it became clear that it would take months of experience for some participants to fully understand how different this project really was.

How will you get teams started? Perhaps the narratives that follow and the lessons we've learned and summarized will give you some ideas.

WHAT'S IMPORTANT AT AN INFORMATIONAL MEETING


Teams Form
Informational Meeting
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Summer Institute
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Periodic Team Work Sessions
Reflection, High-Risk Performance, and Culminating Event

> *What are the concerns that team members may have in the beginning? What pieces of information are important to share? What kind of activities should be included in an "informational meeting?" The following pages describe the first time the Kentucky Team met as a full group. We learned that this gathering was an ideal time and place to highlight the essential elements of this approach to professional development.*

The initial advocates for the Kentucky Team invited all prospective team members to a short informational meeting near the end of their team formation process. The purpose was to enable people who knew or thought that they wanted to become part of this professional development effort to

- gain a clearer understanding of the project they would be working on,
- get to see and learn a bit about the others who would be involved, and
- find answers to their questions.

At 4 PM, a half hour after the students' day ended, ten people gathered around a large conference table in the district's professional development center. The team's "champions" – David, the district's environmental education coordinator and a member of the University of Louisville faculty, and Ken, the district's science curriculum specialist – had organized the meeting. Four elementary school teachers from two schools; a principal from one of the schools; a resource teacher from the other; David's resource teacher, who had helped recruit and train teenagers to guide elementary students in their schoolyard investigations; and Karen Hollweg, the VINE Follow-Through project director from NAAEE, also attended this informational meeting.

Cookies, iced tea, and coffee provided some quick energy and a comfortable background for getting-acquainted conversation. As an icebreaker, David asked all the attendees to introduce themselves and share something in their environment that they had noticed recently; as an example, he introduced himself and told about the beautiful sunrise he had seen on his early morning walk with his daughter.

TEAM BUILDING TIP

Team building takes work and starts early. A group of individuals doesn't become a team automatically. Begin with fun introductions and icebreakers at the first informational meeting where people will be feeling unsure of themselves and their place in the team.

The Kentucky Team (L to R)

Claudia-Science resource teacher.

Margie-Primary teacher, wants to integrate science and the environment into curriculum.

Linda-Teaches fourth grade using state's new assessment procedures.

Ken-District's K-12 science specialist and Eisenhower funds coordinator.

Vicki-Teaches second and third grade using integrated social studies curriculum.

Laura- Primary teacher, emphasizes basic skills.

Sharon-Teaches fourth grade, uses outdoors for instruction.

Fig- Doctoral student and team facilitator.

Merrill-Computer lab teacher.

David- District's environmental education coordinator, local VINE coordinator; also on university faculty.

RED FLAG!

Expectations must be stated not once, not twice, but several times and in several different ways. For individuals who have participated in traditional inservices, the terms *multi-year, team-based,* and *constructivist,* which we used to describe our project, did not convey concepts they had experienced or understood. Give people lots of time and many meetings to experience and develop a deep understanding of this kind of professional development.

Following introductions, Karen gave a brief overview of the project's purpose and timeline as she referred to brightly colored hand-outs (Appendix pages A.1, E.1 and D.2). But the majority of the meeting focused on specific nitty-gritty questions:

> Which dates do I have to save on my summer calendar?
>
> If I agree to do this will you train the volunteers to guide my students in doing both fall and spring outdoor investigations next year?
>
> Who pays for what?

Linda and Sharon discuss how they'd like to see the integration of VINE schoolyard investigations into their ongoing curricula and, at the same time, address Kentucky's fourth-grade writing assessment.

We made a point of setting a friendly tone, accepting and providing direct answers to all questions, and creating a "safe," open atmosphere in which people felt free to say what was on their minds.

"What in the world will we be doing as a team for two years?! This isn't like any other professional development project I've ever participated in!"

Since the school district had set rates of pay for time spent on professional development and had shifted some of its professional development budget to the building level, it was important for all those involved to get a clear picture of the cost-sharing responsibilities. As it turned out, supplemental teacher pay for weekend and summer days, as well as substitute release days, came from building-level professional development, PTA-generated, and district Eisenhower funds. Salaried time of district administrators and university faculty was provided as in-kind contributions. The NSF grant paid the majority of the Summer Institute travel and team facilitator costs.

The meeting cleared up many questions. However, in retrospect, we should have also included more opportunities for participants to engage in activities and discussions contrasting the nature of this project with previous inservice experiences – further developing their concept of this multi-year, team-based effort. By using a device like the one here we would have enabled folks to begin gaining a deeper understanding of the kind of professional development we envisioned. We advocate such an overt, interactive comparison of this project's emphasis versus other approaches as part of the information and recruitment process.

Which Kinds of Professional Development Experiences Do You Want?

Circle the ones in which you would most like to participate.

1. one day topical workshops
2. team efforts with university, district, teacher, and community members working as colleagues
3. courses taught by enthusiastic experts
4. focused one to two year projects that will enable me to develop new skills
5. make-and-take-it sessions
6. opportunities to honestly examine and compare classroom practices with colleagues
7. chances to think about what I'm doing and could do to improve student learning
8. lectures on the latest learning theories
9. experiences that support me in trying new approaches
10. sessions with activities I can do with my students the next day
11. well-organized classes that enable me to really learn the content I'll be tested on
12. courses that model teaching and assessing concepts in integrated ways
13. programs that meet periodically throughout the year

Each kind of professional development experience described here can be valuable. The kind described in this publication emphasizes characteristics described in numbers 2, 4, 6, 7, 9, 12, 13. Give yourself a point for each of these you circled. People who score 5 to 7 points will most likely find a congruency with their interests and the ideas and approaches of the VINE Follow-Through Project.

Once each team member has individually completed and scored his or her responses, discuss your preferences as a team. For example, what types of professional development experiences do the members of your team value most? Why? This discussion should enable your team to assess whether the members are in agreement regarding the long-term nature of this endeavor, the role of the team in planning and supporting new approaches to teaching and learning, and the opportunities members will have to examine their current practices and develop new skills.

Finally, in pairs, review the "Changing Emphases" sheet from the Standards for Professional Development (on Appendix page E.3) and decide the degree to which this type of professional development addresses the Standards. For example, which emphases do you and your discussion partner seek, and why are these priorities for you at this point in your career? Or, which emphases listed in the National Science Education Professional Development Standards seem like they will be most directly addressed by VINE's team-based, problem-centered approach?

Summary

Although one-on-one discussions and small group meetings facilitated much of the team's initial formation, the Kentucky Team, as well as the other two teams, found that an introductory informational meeting was essential. This meeting brought together all prospective participants in a comfortable setting for three purposes:

- to meet their prospective teammates;
- to get straightforward information that answered their questions about who, when, where; and
- to gain a clearer understanding of the project and what would be expected of them.

In addition, by beginning to assess the kinds of professional growth experiences participants wanted and their initial perceptions of this project, we could model constructivist teaching/learning and begin building an understanding of the mode of professional development we were pursuing.

TEAM BUILDING TIP

Build trust. Work to create a safe and open environment so people feel free to discuss what's on their minds. Acknowledge and value the diverse perspectives people bring.

Participants left this meeting intrigued with the idea of working with this new group of people to address a real challenge. How would they get started?

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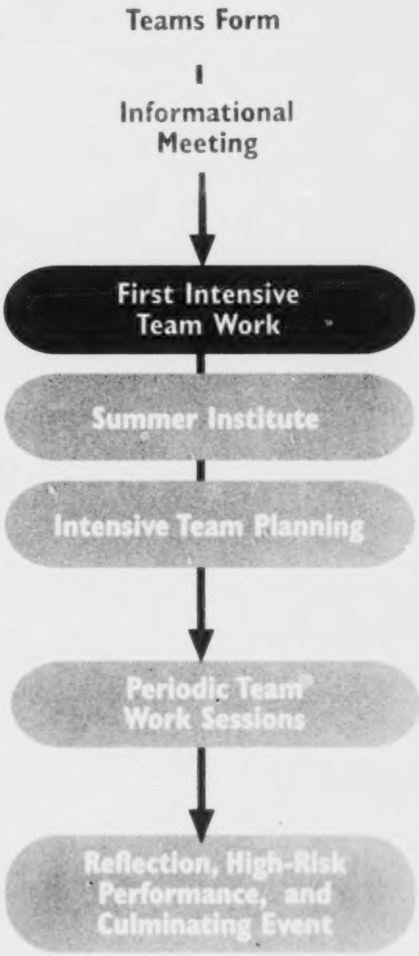
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HOW TEAMS BEGAN ADDRESSING THE CHALLENGE

Pages 48-53 briefly describe the first week of the South Florida Team's intensive work. The members begin to know one another in more depth and define the focus of their VINE Follow-Through effort. They prepare a "team product" to share with other teams during the upcoming Summer Institute.

What is this team product and why did we ask for it? What did South Florida do to prepare this product? What activities did they engage in to get to know one another and build an initial understanding of what each of them, their students, their district curriculum, and state frameworks could contribute to this project?

On a sunny Friday morning, the South Florida Team officially gathered for the first of five days that they would meet in May and June. They spent the day at a local park's meeting facility, away from their regular work sites. Everyone arrived a bit early in casual clothes, with a sack lunch, eager and yet curious to learn more about this project on which they were starting to work.

Barb, the team's facilitator, had planned a full agenda, in consultation with Karen Hollweg, the VINE Follow-Through Project director. It started with welcomes and introductions, donuts, and coffee and tea. Barb provided instant conversation-starters by asking everyone to write four things in the corners of her nametag (the most unusual or scariest thing you've ever done, the best part of your job, your favorite place or way to relax, and why you are in education). The nametags alleviated the somewhat awkward getting-acquainted conversations and promoted more substantive, personal discussions.

Promptly at 9 AM, the meeting began. Printed agendas and bright pink binders had been placed on the tables in front of each seat. Both the amount of organization that was evident and the pleasant, yet matter-of-fact, tone with which Barb reviewed the agenda indicated that a lot of business would get done in this informal setting. She also invited and responded positively to questions and encouraged discussion and divergent views – establishing an open atmosphere. As soon as Patty (the humorist of the team) interjected her first quip, laughter broke out and everyone relaxed more.

TEAM BUILDING TIP

To build individual commitment to the team, team members need to feel that they are contributing in real ways that take advantage of their strengths. They also need to see that together they can do more than they can do as individuals.

Three factors influenced Barb in planning the first day's agenda. First, she knew that her colleagues would be most interested in finding out their **schedule** for the rest of the spring and summer and the **arrangements and logistics** for the July Summer Institute – so she scheduled these items first. She also wanted to engage everyone in small group, interactive tasks – to facilitate their getting to know one another and develop an understanding of the goals and nature of the project. Finally, she felt it important to get started on plans for the team product and give everyone a chance to begin journaling and sharing their entries. This activity would allow them to begin doing creative work together and develop a level of comfort and trust. Barb invited Karen to travel to Florida to participate in this first meeting so that she could meet the team in its infancy and directly address questions concerning project expectations. Karen also led the small group tasks, freeing all members, including Barb, to participate in the initial activities as equals.

Barb planned both structured and open-ended tasks that were designed to help the South Florida Team achieve two objectives. The team would

- **begin building its sense of identity and trust, and enable the people on the team to get to know each other better,** and
- **collect data and begin to analyze *what is*** in their
  - local VINE Program,
  - district curriculum,
  - students' conceptual understandings, and
  - team members' pedagogical views.

During the five days the South Florida Team met, the members spent approximately equal amounts of time building their team and developing a shared understanding of what was occurring in the district. Barb drew from VINE Follow-Through materials to highlight the strategies they would use and the tasks they would accomplish in this first phase of the project. (Appendix pages F.1-16 contains a set of the materials.) They would

- **use "get acquainted" and team building activities**. At this first session, Karen facilitated "The Cube" inquiry (Appendix pages F.4-5), an exercise that has several possible solutions, to demonstrate the value of everyone's input and underscore the notion that the project was not about developing one "correct" answer.

- **identify the content that might best be developed through the VINE Follow-Through Project**. First, teammates developed a list of the skills and ecological concepts that were addressed in the VINE investigations that students had done or could do in their schoolyards. Then they listed the state and district-level student expectations, objectives, or learnings for their designated grade level and compared this list with the concepts and skills in the first list.

- interview at some length two or three children in the targeted grade level to **obtain a deeper understanding of the youngsters' preconceived notions and prior experiences** regarding those concepts.* By sharing what each person

South Florida Team

Curriculum Content

- What concepts(s)/ skill(s) that are part of the approved curriculum will the VINE Follow-Through experience(s) introduce/develop?

Science Process Skills

Communication
Observation
Data Collection
Experimenting
Investigating
Classifying
Interpreting
Analyzing
Questioning
Predicting
Concluding

Key Concepts in All Four Science Modules

Weather Report, Rainforest, Earth & Other Planets, Volcanoes & Earthquakes (as noted in curriculum guides) had learned from these interviews, the team could take into account the feedback from a larger number of children, listen carefully to the views of others (e.g., what surprised each interviewer the most), and practice explaining evidence-based opinions — all aspects of professional development that the project wanted to encourage.

---

* *We provided some background for this task from Leach, et al. (1995, 1996). For more information, see Appendix pages F.11-16 and AAAS (1993).*

- **discuss various pedagogical approaches** using a "Reflecting on Practice" activity (Appendix pages F.6-10) to initiate the discussion, and begin journaling by describing "what you expect to get out of the Summer Institute."

RED FLAG!

When teams work to generate their own questions, find their own solutions, and see that there are many more possible solutions, some folks initially feel frustrated with the lack of direction – and rightfully so.

Don't give up! Don't fall back into the familiar "tell me" approach. Sometimes we need to be "off balance" before we can develop new understandings.

This variety of activities provided all three teams a starting point for discussions and opportunities to learn more about one another's and students' initial views. They also enabled team members to acquire some initial experiences that would help them to understand the constructivist nature of the project.

In addition, the team used what they had done and learned together to **prepare a team product, which would introduce their team to the others**. The team product provided each team with an authentic task on which to focus its efforts, gave the Seattle Design Team members something to use in assessing the incoming understandings of each team as they planned the Summer Institute, and gave each team a means to proudly introduce itself at the beginning of the Institute.

As the team worked, there were obvious indications that this project was different: the two district administrators and university person were not "in charge." Instead, equal weight was given to their questions and comments and to those from the classroom teachers and nonformal educators. The discussions and activities, while engaging and thought-provoking, did not always end with one well-defined answer. A bit of uneasiness surfaced at the end of "The Cube" inquiry when someone asked "Which group's answer is right?" (A similar question regarding the "right answer" emerged in another team as they concluded "Reflecting on Practice.") Reassurances – that differing viewpoints and solutions supported by sound rationale and solid evidence are all "right" – were tentatively accepted. But it took a few months of consistent consideration of divergent views for everyone to fully accept and believe this.

"But what's the right answer?"

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Team Product - due in Seattle no later than June 15

The Seattle Design and Leadership Team wants to make your week in Seattle as enjoyable and productive as possible. To enable them to get to know you and plan for your needs, they are asking that you send them a team product so that they receive it in Seattle no later than June 15. Send to: The Seattle Design Team, c/o Amy Martin, College of Education, University of Washington, 122 Miller Hall- DQ-12, Seattle, WA 98195.

Purpose:

To show the Seattle Team, (1) who you are, as individuals and as a team; (2) what schoolyard investigations you have used in your VINE Program and how these (and any others you are considering using in VINE) fit with your state/district framework and learner outcomes; and (3) to communicate to them your expectations, as individuals and as a team, for the Summer Institute in Seattle.

Parameters:

As you plan your product, please keep in mind both the amount of time you have to create the product and the time it will take the Seattle Team to review it. While we don't want to stifle your creativity, a 2-hour documentary and a 300-page volume is too much.

The Product:

Your product should be a team creation and can include visuals, plus printed text and/or audio communications. Your team needs to decide your format(s). Your choice should take into account time, cost, resources available, and the best medium for your message.

Consider this to be a "marketing" tool – let it show your personalities and skills, make it a bit "wacky," unique, or memorable in some way. While you are going to get a chance to experience Seattle **first-hand** in July, **this** is going to be the way the Seattle Team will get to know you and your home turf. Give them a vivid first impression. And keep in mind the fact that only one of the Seattle Team leaders has ever been to Ft. Lauderdale, and that was during a spring break in college.

Getting Started:

You might start by creating a list of questions you have about Seattle and the Seattle Team, and then turn the tables and assume that they'll want to know similar things about you. By **planning** your product at your first meeting, you'll have time to reflect on, revise, and carry out your plan prior to the deadline.

At the end of their first full day together, as team members shared their journal entries, it was clear that people liked their teammates ("great people/great team") and the joint effort they were involved in. ("It's nice to be part of a team instead of having 'to inservice.'"; "It's dizzying, but this group makes decisions!") They also expressed concerns. ("I'm nervous about lots to do.") But the group was generally pleased with the spirit in which everyone was pulling together in this "honeymoon" stage of the project and was beginning to understand the project to which he or she had committed.

An issue that came to a head and was fully resolved early for the team was attendance. At the team's second or third meeting, one of the district curriculum specialists said that she would be unable to attend the following session, but that the team should go ahead without her. This led to a full and open discussion about the importance of *all* members attending each meeting – and the team agreed on a ground rule that emphasized commitment of both the individuals and the team. Meeting dates would be set ahead, around members' schedules, to make it possible for everyone to attend, barring unforseen circumstances.

"It's great to be a part of a team making decisions instead of being told what to do in an inservice!"

Throughout the five days of beginning meetings, each team member had chances to contribute in special ways that highlighted her expertise. Rose-Marie presented the curriculum framework big picture to show how county objectives fit with the state framework. Pat readily got documents from the Superintendent's office and worked with Rose-Marie to arrange for participants' inservice credit. Joan enthusiastically shared what she had learned from her student concept-interviews, encouraged others to do them, and initiated an interesting discussion about how this kind of strategy might be used in classroom teaching. Everyone contributed to the Treasure Chest and the other parts of their Team Product.

Everyone contributed as the South Florida Team planned and prepared their team product.

By the time they arrived at the Summer Institute, the team showed confidence, spirit, and camaraderie as they introduced themselves with an original rhyming chorus, slide show, matching game, and display of their Florida Treasure Chest.

Summary

The VINE Follow-Through Project recognizes that using a "tell them" approach to initiate a team's involvement does not necessarily lead participants to developing targeted skills and concepts. On the other hand, it is not possible to have everyone begin at "ground zero" and construct everything, just as in a classroom, it is not feasible to have students construct conceptual understandings without guidance from the teacher. Careful crafting of activities and needed tools at crucial times facilitate learning for adults as well as children. With this in mind, the VINE Follow-Through Project leaders provided teams with both structured and open-ended tasks. Each team used the tasks to achieve four objectives in its first week of intensive work. The teams

- **built their sense of team identity and mutual trust** by getting to know each other through getting-acquainted and team-building activities and informal conversations, and working together on group tasks and sharing their views on a range of topics;

- **identified science content** that might best be developed through the VINE Follow- Through Project by listing the skills and ecological concepts addressed in the VINE investigations used locally; listing the relevant state and district-level student expectations, objectives, or learnings for their grade level(s); and finding appropriate overlaps and reinforcing elements in the two lists;

- **began developing a deeper understanding of youngsters' preconceived notions** and prior experiences regarding the identified concepts by each interviewing at some length two or three children in the targeted grade level(s), and discussing what they learned from these interviews; and

- **compared a variety of pedagogical approaches** and discussed their views with their teammates.

Now, what would happen during the Summer Institute? Who would they meet and what would they learn there?

Certificate
of
Certification
PRESENTING
THE FLORIDA TREASURE BOX
BY THE SOUTH FLORIDA VINE FOLLOW-THROUGH TEAM

The South Florida Team's Treasure Chest included everything from sand and a shark jaw to a key lime pie recipe, a mini-crate of oranges, and a highlighted copy of the "Sunshine (state education) Standards."

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THE SUMMER INSTITUTE

What enables teams to work together more effectively? How are participants engaged in constructivist learning as adults? How did teams prepare themselves to apply what they learned to create their own plans? The following section describes the 1995 Summer Institute in Seattle, when the three teams met together for the first time. The goal of the Summer Institute was for participants to gain a deeper understanding of both teamwork and constructivist teaching/learning.

Welcoming Reception

The Summer Institute began with a welcoming reception, a dessert buffet held the evening before the first full day of activity. Teams were eager to share the products they'd created and to see what other groups had put together. The project's Advisory Committee was looking forward to meeting the people involved in the project that they had only read about. The Seattle Design Team was especially excited about meeting in person those they had only known so far by names and products.

Since each person was part of a team that had already shared some experiences, even the more reserved people felt comfortable and confident in this new setting. They learned names and found out who was from where, compared experiences in preparing team products, and engaged in informal talk. The only

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Cruising the dessert buffet at the Welcoming Reception.

"formal" part of the reception was the time allotted for each team to show off its product: South Florida's Treasure Chest, slide show, and chanted rhyme; Kentucky's video; and Seattle's baskets. Even then, the way in which everyone joined in the chorus of Florida's rhyme or laughed at Mark's story about being on the "Gong Show" could hardly be characterized as formal.

Day 1 MONDAY

Introducing Goals, Roles, Expectations, and Participants

All 40 participants met in the Media Center of Roosevelt High School the next morning where trays of fresh fruit awaited them (the beginning of a "morning treat" tradition). The first task was to set forth the goals and expectations of the week and to welcome and introduce everyone in terms of his or her roles and areas of special interest.

Karen, the project director, and Carole, the co-principal investigator, gave an orientation to both the project and to the Summer Institute. Karen pointed to a large chart paper as she spoke about the goal of the Institute, the project challenge, the overall project purpose, and the funding.

She also described the following:

- The unique role of the **Seattle Design Team**, which had started work in 1994 with a Summer Institute and spent a year following through on VINE with students. As leaders of the current Summer Institute, the Seattle Design Team would be sharing its experiences and helping new teams move their plans forward.
- The role that **the ten new Seattle teachers** would play as the district expanded the reach of VINE Follow-Through.
- The roles of each of the multi-faceted **Leadership Teams from Kentucky and South Florida.**
- The outside expertise and perspectives that the **Advisory Committee** members added as they asked questions and pushed the important issue of dissemination.

Goal of the Summer Institute

Participants will gain a deeper understanding of

- **constructivist teaching/learning**

  and
- **teamwork**

so that they will be able to more clearly address the project challenge: to build VINE schoolyard learning experiences into the ongoing classroom curriculum in a way the enables students to do more science and construct meaning from their experiences.

RED FLAG!

Although the information Karen shared at the start of the Institute had already been provided, participants heard and understood it differently each time it was reiterated throughout the project. We found it was important to repeat it in different contexts.

Carole's orientation focused on the Institute's purpose, products, and processes. She gave an overview of the week's activities and dealt with logistics ranging from nametags to meeting times to reading assignments. Participants were

Summer Institute Schedule				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Introducing Goals, Roles, Expectations, and Participants Engaging in Team-based Constructivist Learning: A Model	Exploring & Explaining Team-based Constructivist Learning: A Model	Exploring Roles and Meeting Goals: The Seattle Design Team Shares Its Experience Exploring & Explaining Work Styles	Expanding on Learnings: All Teams Plan for the Coming School Year	Closing Experiences: Team Communications and Celebrations
Daily homework: Reading assignments in Brooks & Brooks *In Search of Understanding: The Case for Constructivist Classrooms* and other opportunities to read and/or view additional examples of constructivist teaching/learning. (See Appendix page H-1 for the complete Reading List.)				

requested to self-assess what they already knew about team building and constructivism by placing sticky signal dots on graphs. This visual representation of the group's self-perceptions at the beginning of the Institute was used as a pre-assessment. She also asked everyone to submit "exit slips" at the end of each day to help guide the Design Team in revising the next day's plans to meet participants' needs.

These two orientation talks were separated by an activity by Kristi, a member of the Design Team. Her activity centered on *The Important Poem*, by the noted children's author Margaret Wise Brown, and gave everyone a chance to get to know and introduce someone he or she did not yet know. The results of the activity, a picture and a poem about each participant, were posted to create a joint bulletin board.

TEAM BUILDING TIP

Begin to create a safe environment with activities like *The Important Poem* in which people get to know one or two others first.

Engaging in Team-Based Constructivist Learning: Introducing a Model for Building on VINE Investigations

Following a break, Bob explained that the next 1 1/2 days would be spent in an adult learning experience. Since reflection on this experience would occur later, he also encouraged participants, especially the providers of professional development, to jot down in their journals things they noticed that were the same as or different from professional development sessions they had led. But he also underscored his hope that they would fully participate as learners. The pace quickened as Bob distributed copies of his letter requesting the group's assistance in determining the habitat diversity of Roosevelt High's urban school grounds.

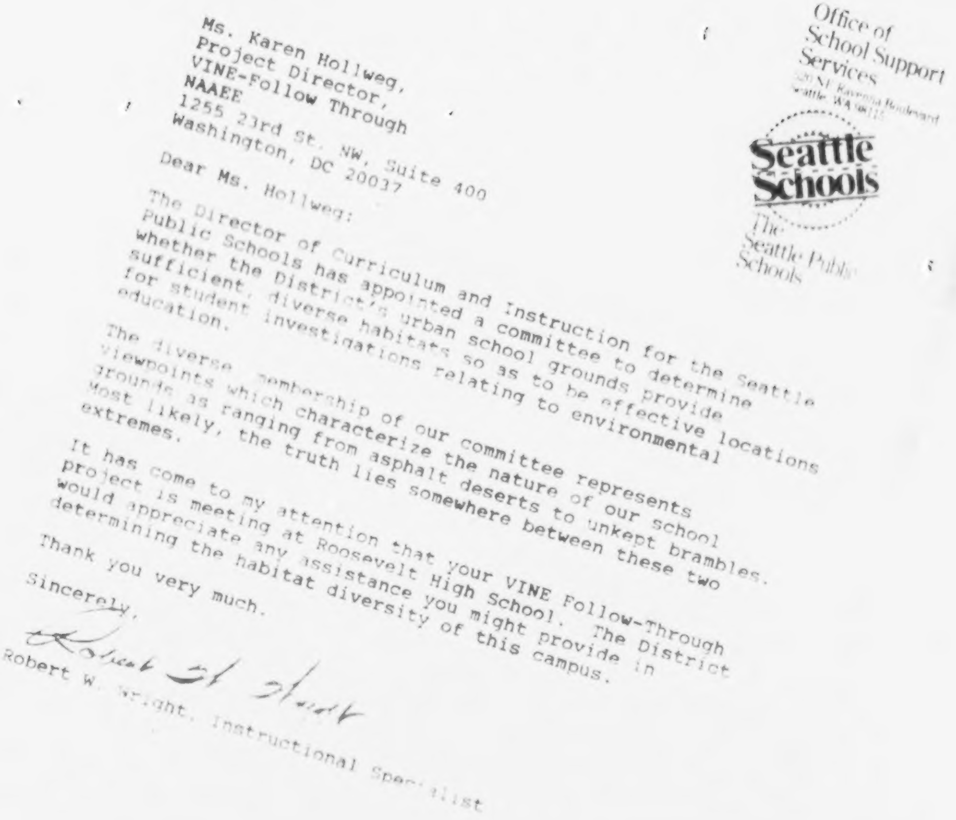
Japhy, another member of the Seattle Design Team, suggested that everyone might contribute by splitting into small groups to go outside and map a portion of the grounds. He unfurled a large map of the campus with the buildings and sidewalks outlined in black and used several questions to assess participants' prior mapping skills and knowledge about habitats:

- Based on what you see and what you already know, what can you tell me about this map?
- How might we use it to create a response for "the committee?"
- What things should we look for outside to determine "habitat diversity?"
- How should we show each of those things? What's important to put on the map?

As soon as a Legend/Key had been decided upon, members of the Design Team led small groups outdoors to complete the OBIS activity *Mapping a Study Site* (OBIS, 1982).

I don't
Know Very Little

Sticky dots graphically showed how much participants felt they already knew about teamwork and constructivism.



Office of
School Support
Services
520 NE Ravenna Boulevard
Seattle, WA 98115

Seattle Schools
The
Seattle Public
Schools

Ms. Karen Hollweg,
Project Director,
VINE-Follow Through
NAAEE
1255 23rd St. NW, Suite 400
Washington, DC 20037

Dear Ms. Hollweg:

The Director of Curriculum and Instruction for the Seattle Public Schools has appointed a committee to determine whether the District's urban school grounds provide sufficient, diverse habitats so as to be effective locations for student investigations relating to environmental education.

The diverse membership of our committee represents viewpoints which characterize the nature of our school grounds as ranging from asphalt deserts to unkept brambles. Most likely, the truth lies somewhere between these two extremes.

It has come to my attention that your VINE Follow-Through project is meeting at Roosevelt High School. The District would appreciate any assistance you might provide in determining the habitat diversity of this campus.

Thank you very much.

Sincerely,

Robert W. Wright

Robert W. Wright, Instructional Specialist

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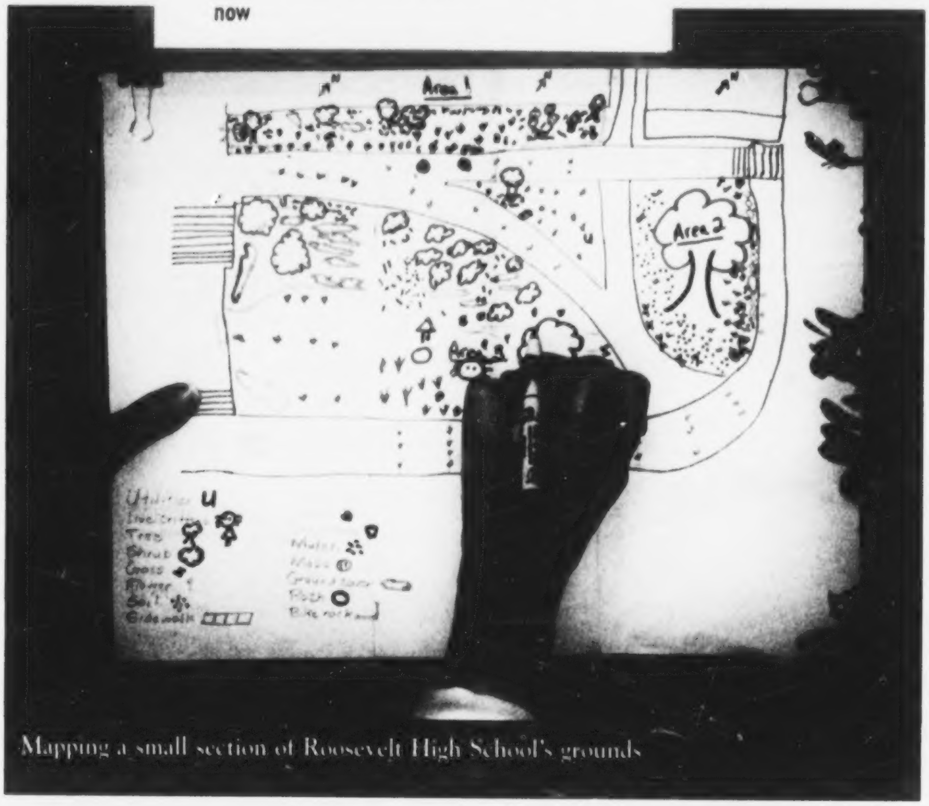
Outline for a Constructivist Learning Experience (about 10 hours class time)

- Introduce Focus/Concept
- Assess Participants' Prior Knowledge
- Engage in guided inquiry, outdoors, using a volunteer-led/VINE investigation
- Pool findings
- Generate new questions and make predictions
- Design and conduct investigations to answer your own questions
- Present evidence and explain what you know now

The Design Team chose this investigation not only because everyone would recognize it as a relevant VINE investigation, but also because it was *not* one of the schoolyard investigations already used in South Florida's and Kentucky's VINE Programs. Therefore, it provided participants with a common learning experience that was new and different. Outdoors, as each small group proceeded to explore and map the different types of habitat in its area with the Design Team members, everyone recognized the similarity of what the groups were doing to what their students did with their volunteer leaders in the local VINE Programs.



Mapping a small section of Roosevelt High School's grounds

In short order, each group discovered, mapped, and discussed the variety of habitat types that existed in its portion of the school grounds. Several uncovered surprises. Then during lunch, each group put its section of map together with those of the other groups to reconstitute the big campus map, and participants started seeing some interesting findings and patterns as they admired their creation.

Following lunch, Bob led a large group discussion that focused on reactions to the mapping experience and possible directions in which to take it. Bob ended the discussion by asking everyone to spend ten minutes writing in his or her journal on two topics:

- your understanding of "habitat," and
- questions you have about the habitats on this school ground that might be interesting to pursue.

As people finished writing, Bob sketched out the next segment of the Institute. Starting with the questions that members had recorded in their journals, each of the small groups would agree on a question to pursue through further inves-

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tigation. The "answer" to the self-generated question would provide "the committee" with further insights about the habitats surrounding Roosevelt High School. By the end of the day, Bob requested that the group members

- agree on "their" question,
- either individually or as a group predict the answer that might be found, and
- identify equipment and materials needed and convey those needs to Design Team members.

The teams generated a variety of interesting questions and predictions. Questions ranged from "Is there enough difference/variation in the environmental factors here to consider the schoolyard 'diverse?'" to "Are there things living in the water inside/under the drainage grates, and, if so, are they the same under different grates?" Groups requested windmeters, insect nets, ropes, containers, and other gear to help them collect data. They were obviously interested in finding answers to their questions, and people with more experience collecting field data explained various options and procedures to their teammates.

> **"To me the most exciting aspect was the unknown and the newness of the whole experience: being in a different environment, working with different people, and sharing new ideas. I think there can be a parallel with kids as far as studying science concepts in a new environment (outside as opposed to classroom or lab), and working with different groups of students. I believe the freshness of the approach is what I can best bring to the students in my room this year."**

RED FLAG!

You will never have everyone at the same starting place in understanding professional development concepts, just as a classroom never has children beginning at the same place in their understanding of academic concepts. People fall along the spectrum from "novices" to "very knowledgeable." Those whose understandings are more sophisticated or well developed than others, may feel that they already know what you are offering...and that may be true! While it is important to recognize their expertise, some may be confused about GIVING information versus HELPING to CONSTRUCT knowledge. For those who are used to providing professional development experiences in which the primary mode of knowledge transfer is "giving" knowledge rather than facilitating the "constructing" of knowledge, the VINE Follow-Through experience can create dissonance and frustration. Have faith – it will be in the working through of the dissonance and frustration that new and deeper understanding of powerful professional development occurs.

> **"The *Mapping A Study Site* experience gave me a new appreciation of what we could ask our students to do. I was also taken with the fact that we were so motivated to answer our own question — more motivated than answering the original question that was given to us. *Mapping A Study Site* was also valuable because it gave us a common experience that we could talk about."**

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Day 2 TUESDAY

Exploring and Explaining Team-Based Constructivist Learning: Concluding Team Investigations

As people arrived on Tuesday morning, Anita, Martha, and other Design Team members passed out the equipment they had collected for the groups. Before the groups headed outside, Bob made a few brief announcements and requested that the groups be prepared to present their results immediately following lunch. He asked each group to include four elements in a fifteen- to twenty-minute presentation (see box).

Bob's Charge to the Groups

Be sure to include in your presentation

- **Your question and predicted answer(s)**
- **How you chose to answer it**
- **What you found out (Was it what you predicted? How will you depict your findings?)**
- **What additional questions you have now**

While the five groups worked, the Design Team leaders circulated, listening to and observing the groups to learn about their understanding of "habitat," their data collecting and interpreting abilities, and their team and small group skills. Participants possessed a range of understandings and abilities and learned from each other. For example, one nonformal educator was explaining to two teachers the factors needed for different plants and animals to survive. A teacher was describing to an administrator her students' mapping skills.

Nearby, a group of teachers, an administrator, and a university educator were discussing how much fourth graders would enjoy this kind of inquiry experience, but questioned where it could fit in the mandated curriculum. Occasionally, one of the leaders would ask questions of a group to encourage them to think about something in a different way – for example, "Someone could say your temperature comparisons are not fair because you're taking the ones in the front of the school later in the day than the ones in the shady back of the school. Is there a way you could make the comparison more fair and accurate?" And with another group, "Does the fact that there are many different species here necessarily mean that there are different habitats?"

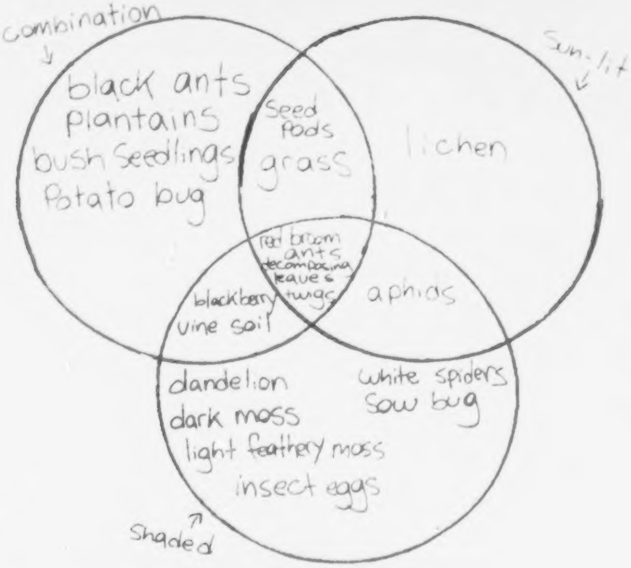
"It would have been neat to invite an ecologist to witness the presentations and comment on how the presenters' work and findings compare with ecologists' views and studies of habitats."

There were lively discussions within groups about how to present their findings. The group that sampled three areas to find the number of different plants and animals used lists and displays. Other groups used graphs, poems, or transparency diagrams. A group that used a Venn diagram (see page 61) to show the different types of plants and animals its members found in sunny, shaded, and "combination" sidewalk sites added a writing prompt to show how the activity could be used as an authentic assessment item.

After the groups had finished their presentations, Bob thanked them for the convincing evidence regarding habitat diversity. Before they turned in their exit slips for the day, Japhy asked them to turn to their journals, reflect on the last two days, and write their personal reactions from two different perspectives:

- As a learner, what particularly struck you?
- As an educator, how did and how didn't the activities relate to a learning model that follows the **4E** organizers:
  Engage/invite,
  Explore,
  Explain,
  Expand/apply?*

Open Response Assessment Item: Looking at the Venn diagram, what conclusion can you draw about the plant and animal life in the sidewalk areas? Explain your answer.


combination
Sun-lit
Shaded
black ants
plantains
bush Seedlings
Potato bug
Seed pods
grass
lichen
red brown ants
decomposing leaves
twigs
blackberry vine
soil
aphids
dandelion
dark moss
light feathery moss
insect eggs
white spiders
Sow bug

The group that investigated the habitats under the drainage grates discovered that the amount of water, the pH, and the organisms living under each was different — results that they had not predicted!

*The 4Es are a variation of the learning model presented on Appendix pages H.27-28.

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Day 3 WEDNESDAY

Exploring Roles and Meeting Goals: The Seattle Design Team Shares Its Experiences

On Wednesday morning, each team met to share reactions, analyze its experiences during the first part of the Institute, and relate its reactions to the reading assignments. Some participants could see ways in which their investigations of the last 1 1/2 days related to what might be done with VINE Follow-Through in their schools. Others were frustrated – either because they didn't see any differences between the inservices they led back home and the Institute or because they didn't see how their team could do Follow-Through experiences like these in their own settings.

Tuesday afternoon exit slips had also signaled that the participants were anxious to know more about the roles that the various Design Team members played in VINE Follow-Through. The Design Team appeared to have no obvious leader who "ran the Institute." Leadership responsibilities had been shared so that at anytime a team member could step in and facilitate any portion of the Institute. And yet, Design Team teachers had specific roles that they had fulfilled. How had their roles played out during the year? Likewise, what had the non-teachers – university staff, district curriculum supervisor, local VINE coordinators – done?

Seattle Team's Goals

- To become a team
- **To develop strategies for following through on the VINE outdoor investigations.**

There was now a tremendous "need to know" the answers to these and other questions. So on Wednesday morning, the Seattle Design Team's teachers and non-teachers took turns providing answers and sharing their experiences as they worked on their goals with teammates during the previous year.

The design team teachers speak

The Design Team teachers gathered as a panel to address several questions:

- What were some of the skills that students needed to conduct the outdoor investigations?
- What happened between planning and implementation of activities?
- What worked and what didn't work?
- What are some new perspectives you have now?

The Design Team teachers discussed some of the strategies they had used with their students during the year. **Japhy** explained, for example, that he had used a real problem with his class: where to situate a new portable classroom on their school grounds. The principal presented this problem to the class to provide an authentic context to introduce the mapping activity. With the Seattle Audubon volunteers, Japhy's students used *Mapping a Study Site* and three other outdoor activities to map and learn about their school grounds. Then, using their new information, they came up with several options for the placement of the portable classroom to present to their principal.

Students in Japhy Whalen's class display Option 5, complete with rationale, of where to situate their school's new portable.

Susan presented her class with the problem of how to improve the schoolyard to make it suitable for more different kinds of plants and animals. The students drew up a working plan to answer the question, researched the best kinds of plants to have, looked at gardening books, and called nurseries and other sources for information. They added this information to their data from *Terrestrial Hi-Lo Hunt* and other activities led by the Seattle Audubon volunteers. They recommended planting three native bushes and specified places best suited for their growth.

Mark's class focused on putting data into picture form. They practiced this skill in small groups with buttons prior to their attempts to graph outdoor creatures they would find in leaf litter. Mark noted how observant the students became as they noticed more and more detail in the buttons, investigated different ways of displaying data, and discussed the variables they were using. In addition, they became very good at peer reviewing and critiquing each other's graphs. He felt that his students' sense of confidence in their ability to conduct scientific investigations rose.

A team of students in Mark's class graph their data.

Kristi's students were presented with a letter from Bob requesting information about their schoolyard habitats. Since many kinds of creatures lived in different habitats in her classroom, Kristi began by having her students list "What We Know About Habitats" and then narrowed it down to "Schoolyard Habitats." Then they listed "What We Need to Know" in order to respond to Bob's request. Her students focused on birds but didn't want to put specific trees in the schoolyard or do anything to change the habitat. Instead, they recommended buying feeders! As she discussed what had gone on in her classroom, Kristi showed giant posters and charts of information her students had generated. She commented that she liked the strategy of using a letter to present a problem scenario, as Bob had done with Institute participants.

The Design Team teachers shared other activities they did with their students to prepare them for their outdoor activities and problem-solving ventures. They found students needed to develop such skills as how to make observations, use a hand lens, and classify objects. As the teachers talked, they referred to the various student products that they had posted throughout the room. They also emphasized that the Design Team's experiences as a team affected the teaching strategies they used back in their classrooms. As they gained insight on the power of multiple perspectives, they all provided more collaborative learning opportunities for their students. For example, Susan, a veteran teacher who had always had her students sit in rows in individual desks, shared how she had found small group work so valuable that in order to facilitate collaboration, she had replaced the desks with tables.

Things had not always gone smoothly for the Design Team, and they **shared the rocky times** as well. For example, Carole, the university person on the Design Team, and Bob, the district science specialist, had to miss the last week of the first Summer Institute. They had thought that this would be okay since they had perceived themselves as "consultants" to the Design Team. Their teammates felt that they had been deserted when they needed Carole and Bob the most. The team was pushed to complete a plan for the coming school year without them. At the subsequent meeting in the fall, relationships were frosty until teammates discussed their feelings and they all came to the realization that there could be no "consultants" on the team. They also recognized that they had missed not only Carole's and Bob's ideas, but also the upbeat way Carole connected people together and Bob's knowledge of the district and its curriculum.

The Design Team had learned an important lesson: effective teams pay as much attention to maintaining the relationships of the people within the team as they do to accomplishing the team's task. This was one of the reasons that the Design Team would focus considerable time and attention on building the new teams during the Summer Institute.

The design team non-teachers speak

When the Design Team teachers' panel concluded, the non-teacher members spoke about their roles. In addition to different perspectives, they contributed specific job-related tasks to the team's success.

Roles People Play

In any complex change effort, there are many tasks that need to be completed. The great thing about a team is that there are teammates who can take the responsibility for particular tasks. This doesn't necessarily mean that the person must carry out the task but it DOES mean that he or she has the primary responsibility of worrying about that task.

In addition to task-related roles, there are social roles fulfilled by different people at different times. There are humorists, nurturers, seers, politicians, etc. These social roles are just as critical to a team as task-related roles.

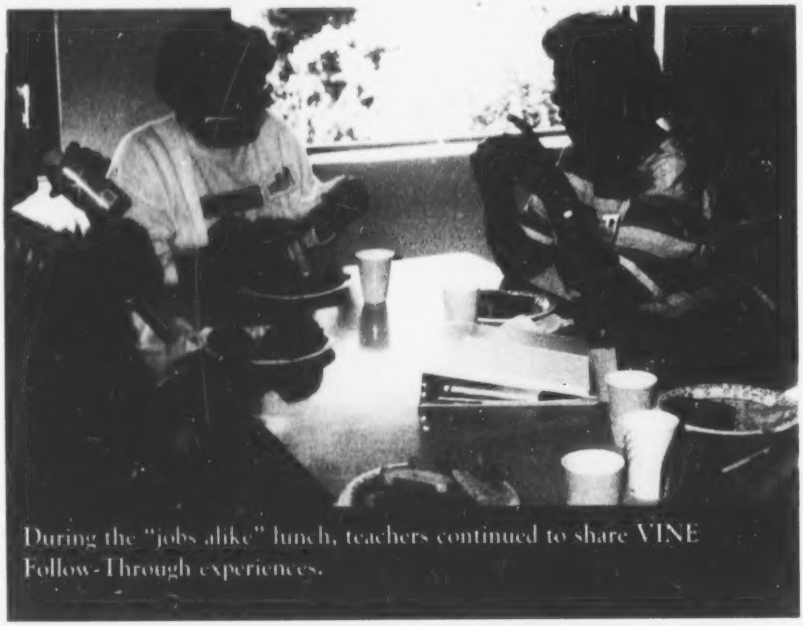
See Appendix page G.1 for a list of some of the roles that might be filled by various team members.

Bob, the district science specialist, related how he was able to authorize the use of Eisenhower Math/Science grant money to pay for substitutes so that the teachers could attend all-day meetings. Because he knew the principals, he had easy access to the teachers' classrooms. For example, he introduced the habitat scenario at Kristi's school. He also was the liaison to the Assistant Superintendent for Curriculum and made sure that she remained aware of VINE Follow-Through.

Anita, the local VINE Coordinator, described how the program worked in Seattle with Audubon and parent volunteers visiting teachers' classrooms once a week for a month in the fall and spring to lead children in outdoor activities. Anita had prepared the volunteers and worked with them in the Design Team teachers' schools. She had been instrumental in identifying the Design Team teachers and recruiting them to participate in VINE Follow-Through.

Carole, the university person, spoke last and described the transformation that she had undergone from being a "consultant" to a "collaborator," a role that university faculty do not often play. She had been able to lend her expertise in adult learning and background in science education to the team. In addition, she was able to arrange for university credits for the teachers. She also visited the teachers' schools to meet with their principals and provide moral support.

Amy was a **graduate student** working on her master's degree in education. She had an extensive background in curriculum development for nonformal institutions and brought her understanding of curriculum to the team. She was the team "organizer" and disseminated meeting minutes, phone lists, and other information to the team. She also helped Japhy work with the fourth graders at his school on VINE Follow-Through.



During the "jobs alike" lunch, teachers continued to share VINE Follow-Through experiences.

By the time the panel had concluded, it was time for lunch. During lunch the group split into "jobs alike" discussion groups. Teachers from all the teams were anxious to find out more about the Design Team teachers' activities and to talk among themselves about what they could do in their own classrooms. The non-teachers split into groups of nonformal educators, science district coordinators, team coordinators, and university members to talk about the particular resources they could offer to support their team's work. Since most of the non-teachers were used to more of a "training model" in which they were the experts, their conversation included how to encourage equality of all team members.

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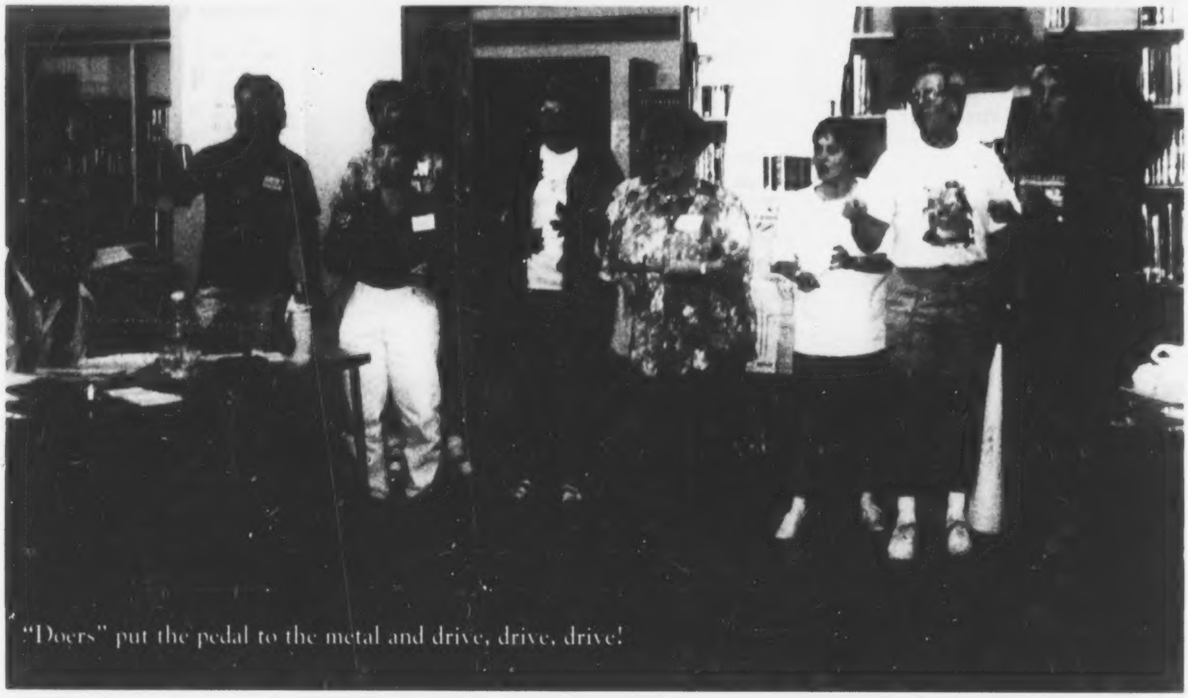
"Amiables" singing a getting-along-together song



"Doers" put the pedal to the metal and drive, drive, drive!

Exploring and Explaining Work Styles

After lunch the focus shifted to team building, and Carole facilitated a group activity called Work Styles Profile (Appendix pages G.2-7). The Design Team had weathered hard times and knew that the intensity and ups and downs of a year-long focus could either make or break a team. One thing that would help the teams through frustrating periods would be the ability of team members to understand different work styles and needs.

"Analytics" asking for more information

Everyone filled out a work styles inventory to find out whether his or her predominant work style was as an "Expressive," an "Amiable," an "Analytic," or a "Doer." Then all the Expressives, Amiables, Analytics, and Doers gathered in like groups to brainstorm ways they might help a team, ways they might hinder a team, and ways that they might be misunderstood by others. An additional task for each work style group was to come up with a slogan, song, bumper sticker, or some other way to demonstrate the "essence" of its work style. The fun part was watching each work style group demonstrate its "essence." There was much laughter and many comments like, "Now I understand why I do things the way I do and why you do things the way you do!"

"Expressives" emoting

The groups cheered each other's presentations. The non-Doers came to appreciate that Doers aren't bossy, but it can look that way because they are task-oriented. Amiables aren't wishy-washy but have definite opinions that they share in gentle ways. Analytics don't want to drag their feet but sometimes it looks that way when all they want are good data before they come to decisions. Expressives really have good ideas and can be taken seriously, even though it can look like all they want to do is have a good time. These insights into each other's work styles increased teammates' patience with one another, helped them to "cut each other some slack," and gave them deeper appreciation of the value of each person to the team.

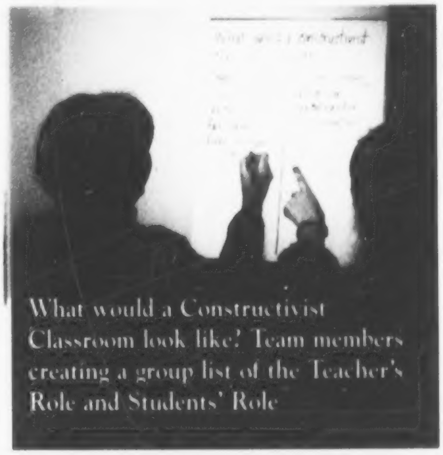
Even at the end of a long day, the room was humming with ideas and energy. Everyone was asked to read Part III of *The Case for Constructivist Classrooms* (Brooks and Brooks, 1993) and be prepared to discuss the teacher's and students' roles in a constructivist classroom.

Day 4 THURSDAY

Expanding on Learnings: All Teams Plan for the Coming School Year

For some participants, the previous three days had introduced new ideas for teaching, learning, and working in groups. For others, the activities had reinforced much of what they already believed. It was now time for the various teams to apply their understandings to their own school district situations.

The day began when Mark asked everyone to reflect on his or her experiences and readings during the week and then draw up a list describing the teacher's role and the students' role in a constructivist classroom. The room was quiet as each person created his or her own list. As a way to get on the same wavelength and to understand each other's thinking regarding constructivism, Mark then asked each team to draw on the individual journal entries of its teammates to come up with a group list. Teams were asked to refer to this list often during the coming year to check their progress in creating constructivist classrooms and to see if or how their thoughts about a constructivist classroom might evolve or become clearer.



What would a Constructivist Classroom look like? Team members creating a group list of the Teacher's Role and Students' Role

After about an hour of clarifying ideas with one another, teams were ready to tackle planning VINE Follow-Through activities and goals for the coming year. To facilitate planning, Mark gave the teams a list of questions (see box) and asked each team to present its initial plans to the large group on Friday morning. Teams spent the rest of the day in intense planning. Friday would be the last day they would have to tap into the entire group's collective wisdom and experience before they departed to their own cities, schools, and classrooms.

Seattle team planning the coming year

Issues to Address in Team Planning

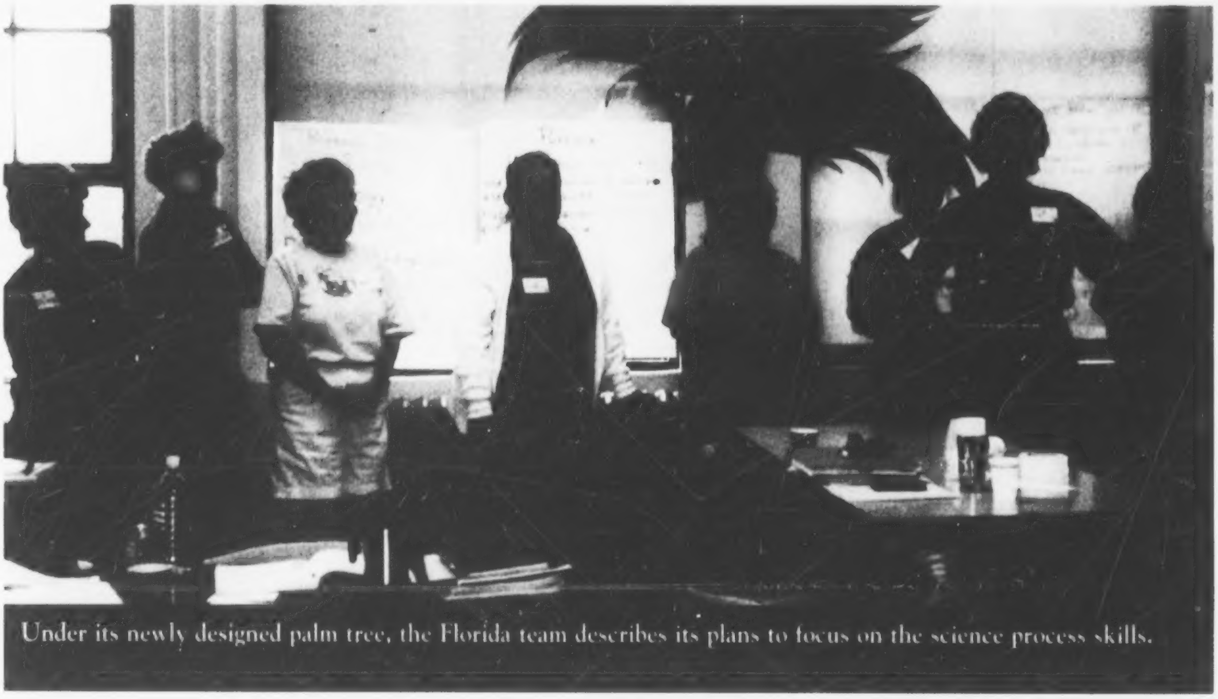
- What will be your team's goal(s) for the next year?
- What does your team want to have accomplished by this time next year?
- How will your team measure its accomplishments? What indicators of progress will you use along the way?
- How will your team share leadership, roles, and responsibilities?
- When (specific dates) and where will your team meet?
- How will your plan mesh with your district's science framework and/or state science standards?

Day 5 FRIDAY

Closing Experiences: Team Communications and Celebrations

The last day of the VINE Follow-Through Summer Institute began with Jean, one of the project's evaluators, describing the evaluation plan and the information she needed from the teams and teachers during the coming year.

Then each team presented its initial plans for the year and heard what the other teams were planning to do. The Florida team had prepared a huge graphic of a palm tree to represent the science process skills it would focus on during the year. The Kentucky team explained its plan to develop students' understanding of the concept of habitat and focus students' learning on a culminating performance event. The Seattle Design Team teachers had decided to "buddy up" with the ten new Seattle teachers and had spent time reviewing the OBIS activities that would be used in their classrooms the next year.



Under its newly designed palm tree, the Florida team describes its plans to focus on the science process skills.

The Design Team ended the Institute with team building activities to remind everyone how important the team would be to each person during the coming year. Immediately following lunch, Carole facilitated "Airplane," a hilarious activity that stresses the need for clear lines of communication and also provides a reminder of how people with varying work styles might react in frustrating situations (Appendix pages G.8-16).

Goal of the Summer Institute

Participants will gain a deeper understanding of

- constructivist teaching/learning
  and
- teamwork

so that they will be able to more clearly address the project challenge: to build VINE schoolyard learning experiences into the ongoing classroom curriculum in a way the enables students to do more science and construct meaning from their experiences.

Tension escalated as the activity proceeded and time to "land the airplanes" drew near. Once all had recovered from the landing (or crash) and the accompanying laughter, they debriefed their experience. Then the entire group revisited the "Goal of the Summer Institute" that had been posted the first day.

Teams agreed that they had spent the week engaging in activities that were sending them well on their way to meeting the project challenge. Their "post" signal dots on the self-assessment graphs showed that they felt they knew more about constructivism and teamwork than they did on the Institute's first day. Their products and interactions also reflected that progress. Carole asked everyone to complete one last journal entry: What are you still anxious about and what are you excited about? Teams could then use this entry as a discussion starter when they met together in the fall.

RED FLAG!

Although an excellent activity that makes a clear point about the importance of communication, "Airplane" is a relatively high risk activity and should only be done after individuals are comfortable with one another. "Airplane" also requires ten or more people to be successful; the more people participating, the more fun it is and the more "ahas" the group will have.

At last it was time for closing ceremonies. Everyone gathered in a big circle with Kristi standing in the center. She reminded them that the Institute had begun with *The Important Poem*, introducing each person to one other. As the week progressed, the circle had expanded so that people came to know all the

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others. As a memento of the Summer Institute, Kristi gave each person his or her own Important Poem that had been posted all week. In turn, each person in the circle was asked to offer a few words about what he or she appreciated about the adjacent person and also what he or she hoped for the future of the project. In tribute to the teamwork modeled by the Design Team, someone from Florida said her team wanted to be "like the Seattle Design Team!"

With a round of applause for everyone's participation and cooperation, the last meeting of the Summer Institute concluded, people scurried around cleaning up, and within thirty minutes of adjourning, everyone was celebrating with a wonderful bar-b-que.

The Summer Institute was over. What would the coming year bring to the Seattle, South Florida, and Kentucky teams?

Kristi leads the closing ceremonies.

Summary

The Summer Institute was designed to build participants' understandings of teamwork and constructivism. It gave participants a set of common experiences and had **four major elements:**

- **Building a team.** The team building that was initiated as teams began addressing the challenge (pages 48-53) continued throughout the Summer Institute. Team building activities helped participants come to know, understand, and appreciate their colleagues and their differences in work styles more fully, including how different work styles contribute to a team.

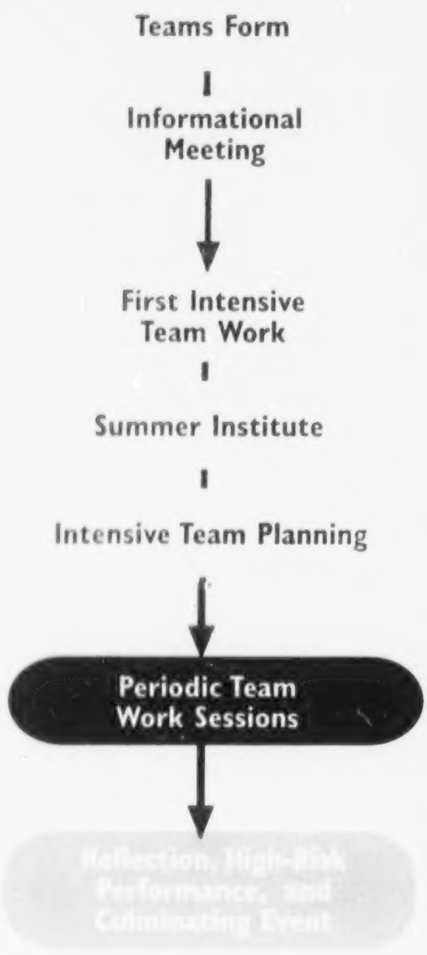
- **Engaging participants in constructivist learning as adults.** Participants engaged in a 1 1/2 day concept-based learning experience. The experience modeled the VINE Follow-Through approach in a series of lessons that built on a VINE investigation in a way that enabled learners to develop a better understanding of an ecological concept. It was important to do the investigation on the school grounds – a novel learning environment where participants could actively engage in inquiry and be unencumbered by traditional notions of school learning – as a model for learning experiences that could be used with younger students.

- **Providing additional examples of constructivist teaching/learning.** Participants' Institute experiences were supplemented by homework. Recommended resource materials included a text, *In Search of Understanding: The Case for Constructivist Classrooms*, and an outstanding article, "Teaching for Conceptual Change: Confronting Children's Experience." (Both are referenced in the "Reading List" on Appendix page H.1.) The stories from all three teams printed in this publication provide additional examples.

- **Enabling each team to apply what it learned to create its own definitions and plans.** Each team synthesized what it had gained from the readings and experiences to create a poster on which members listed the things teachers do and students do in a constructivist classroom. Finally, teams applied what they had learned as they set their goals for the coming school year and created plans for pursuing their goals. The questions on page 68 focused teams' planning sessions.

With the Summer Institute concluded, how would participants continue their professional growth over the next nine months as they pursued their goals with their teammates?

HOW TEAMS WORKED TOGETHER THROUGHOUT THE SCHOOL YEAR


Teams Form
Informational Meeting
First Intensive Team Work
Summer Institute
Intensive Team Planning
Periodic Team Work Sessions
Reflection, High-Risk Performance, and Culminating Event

The Kentucky Team's Story

> *What are the challenges to sustaining year-long professional development efforts? How are these challenges met and overcome? How do students benefit from long-term, team-based professional development experiences? The following section contains stories from Kentucky and Seattle to answer these questions. The Kentucky Team's story spans the entire school year, while the Seattle Team's zeroes in on one particularly traumatic meeting. Both offer insights into how this professional development experience differed from more traditional ones in both the ways the participants interacted with one another and the changes that resulted for them and their students.*

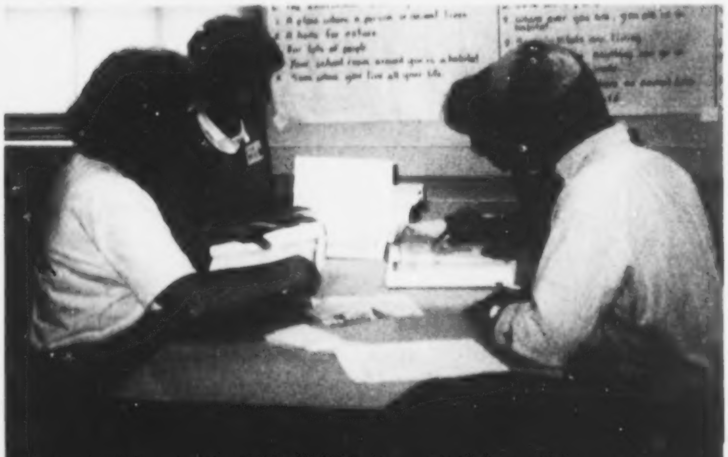
As the Summer Institute came to an end, the Kentucky Team, like the other teams, had established a plan and a calendar of seven meeting dates spread throughout the school year. As with the other teams, there was no instructor and no set curriculum or syllabus for them to follow. Similar to the other teams, the Kentucky Team had

- **a goal** that it had set for itself,
- team members who possessed **a diverse array of knowledge and skills**,
- access to considerable **resources** from their institutions and communities, and
- a real **sense of ownership** as it set out to accomplish its goal.

By mid-summer, the Kentucky Follow-Through Team was ready to apply what it had learned at the Summer Institute and plan a series of learning experiences to enable students to build on their volunteer-led outdoor investigations in a constructivist way.

The Kentucky Team members thought that building a series of outdoor investigations around the idea of **habitat diversity**, as they had done in the Summer Institute, would also work with their students. They selected *Worm Worlds* (Berkowitz and Bohlen, 1996) and five investigations from the OBIS series: *Mapping A Study Site*, *Terrestrial Hi-Lo Hunt*, *Plant Hunt*, *Animal Diversity*, and *Plant Patterns*. Their local VINE volunteers would be trained to lead the children in these investigations and facilitate management of the classes' outdoor explorations.

Ken, the K-12 science specialist, challenged the team to keep the Kentucky Education Reform Act (KERA) in mind and, using the district's "Curriculum Planning Map," build plans around a culminating performance. In a spirited discussion, the team became excited about the idea of ending the students' year-long explorations of their own school's grounds with an opportunity to visit, explore, and compare their school grounds with the grounds of another school. It seemed a natural context for their students' efforts and a most appropriate way to enable them to display their skills and apply their understandings in a new environment.



Team members reviewed the district's curriculum guides and academic expectations for students to make sure their Follow-Through plans focused on identified skills and concepts.

The team reviewed the district's standards and concluded that its plan addressed the district's **Academic Expectations** for using relevant science skills in real-life situations to

- identify patterns and predict outcomes,
- describe systems and their interactions,
- use models and scale to explain the organization and behavior of living things in their environment, and
- describe change over time.

They needed to design "open response" questions to prompt their students' written explanations and "scoring guides" to use in evaluating the degree of mastery each student showed in his or her writing. They also needed to plan and develop a scoring guide for the culminating performance assessment. But in the two days they had scheduled for team meetings before school started, they would focus on their detailed plans for the fall. The rest would get done at the five meetings spread throughout the school year. It would be a lot of work, but with the whole team working together, they felt they could do it.

"We need to cut back and do fewer outdoor investigations so that we can spend more time on the ones we do."

"One of the perks of VINE Follow-Through is being allowed the time to interact with other educators. It enriches our teaching."

Some of this initial enthusiasm was eclipsed by all that needed to be done to start the school year. The teachers and university representatives were busy with their new classes; the administrators and program heads were busy with the meetings and paperwork required to begin the new school year. On the scheduled dates, the team members welcomed the times they had allocated to work together. During their Saturday and substitute release-day meetings, they set up joint calendars and designed a scenario to introduce students to the school grounds' challenge and the culminating event. The team decided that it would be more realistic to work with only two schoolyard investigations in the fall, and planned activities to lead into and follow through on *Mapping a Study Site* and *Plant Hunt*. Most of the lead-in and follow-through activities were hands-on, focused on process skills, and involved students in wondering, sorting, and classifying. Most were teacher-led. Some of the activities came from the Summer Institute; others had been used by one or more team members in the past. In keeping with KERA, the team developed open response questions and rubrics for assessing student progress.

All this work and a sense of accomplishment brought the team together. They were getting to know each other well enough that there was a sense of camaraderie each time they got together. The teachers' self-confidence grew, too. They were comfortable sharing what they had done with one another and asking the team for suggestions. By October, teachers were adapting the team's plans as they each deemed appropriate for their own students' abilities and levels of understanding. They also realized how interdisciplinary their plans were, as they recognized that the assessments enabled students to demonstrate progress in math, social studies, and language arts, as well as science.

"In team meetings, the team members who were more removed from the daily demands of classrooms sometimes had the distance and perspective to cut to the chase and ask critical questions or redirect discussions."

The team spirit increased the level of warmth, involvement, and candor with which the members interacted. By the end of November, each teacher had implemented the planned curriculum with his or her class and had a chance to reflect on the results. When they got together for their December meeting, which they had decided to turn into a holiday party with significant others, they were genuinely pleased with their progress.

By the February meeting, the team was ready to focus on the year-end performance event. The discussion began with several members describing what they envisioned. Soon it became apparent that their concepts of the performance event were quite different. Some team members foresaw students collecting data and making observations at the new school site they would be visiting. Others saw their students teaching the visiting students hands-on activities (such as making "tree cookies" and counting tree rings). Soon, Fig, the team's facilitator, jumped to her feet, wrote on the board, and asked: **"What do we want the kids to know and be able to do?"**

The team grappled with this question for several hours at this and their next meeting. At times the discussion focused directly on the question and drafts of outcome statements were offered. Then the discussion would move to a request for concrete examples (How would you get that to happen?) and to logistical considerations (How will we get that done between the time the buses drop the kids off and pick them up again?). Finally, at an all-day meeting near the end of March, the team reached agreement. They concluded that the main content driving the performance event would be: **Environmental factors (i.e., moisture, temperature, wind, light, plants, and animals) influence the diversity of plants and animals.** The open response question/ writing prompt for evaluation of the concept would be: What affects the plant and animal life in our schoolyard? A four-point scoring guide was developed to use in judging students' writings.

Main content driving the performance event **Environmental factors (i.e., moisture, temperature, wind, light, plants, and animals) influence the diversity of plants and animals.**

The writing prompt for evaluation **What affects the plant and animal life in our schoolyard?**

Concept Scoring Guide

4	Compares Dunn and Kerrick school campuses Applies experiences Detailed descriptions of environmental factors impacting plants and animal diversity Several examples given that reflect environmental factors Applies learning to other environmental settings (not just Dunn and Kerrick) Has more details, more examples, and compares at least 2 sites
3	Response indicates that environmental factors (i.e., moisture, light, temperature, etc.) affect plants and animals Student gives examples of factors and their impact in the response
2	Discusses environment or plant and animal diversity but does not relate the two
1	Flying Toasters -- totally off the topic

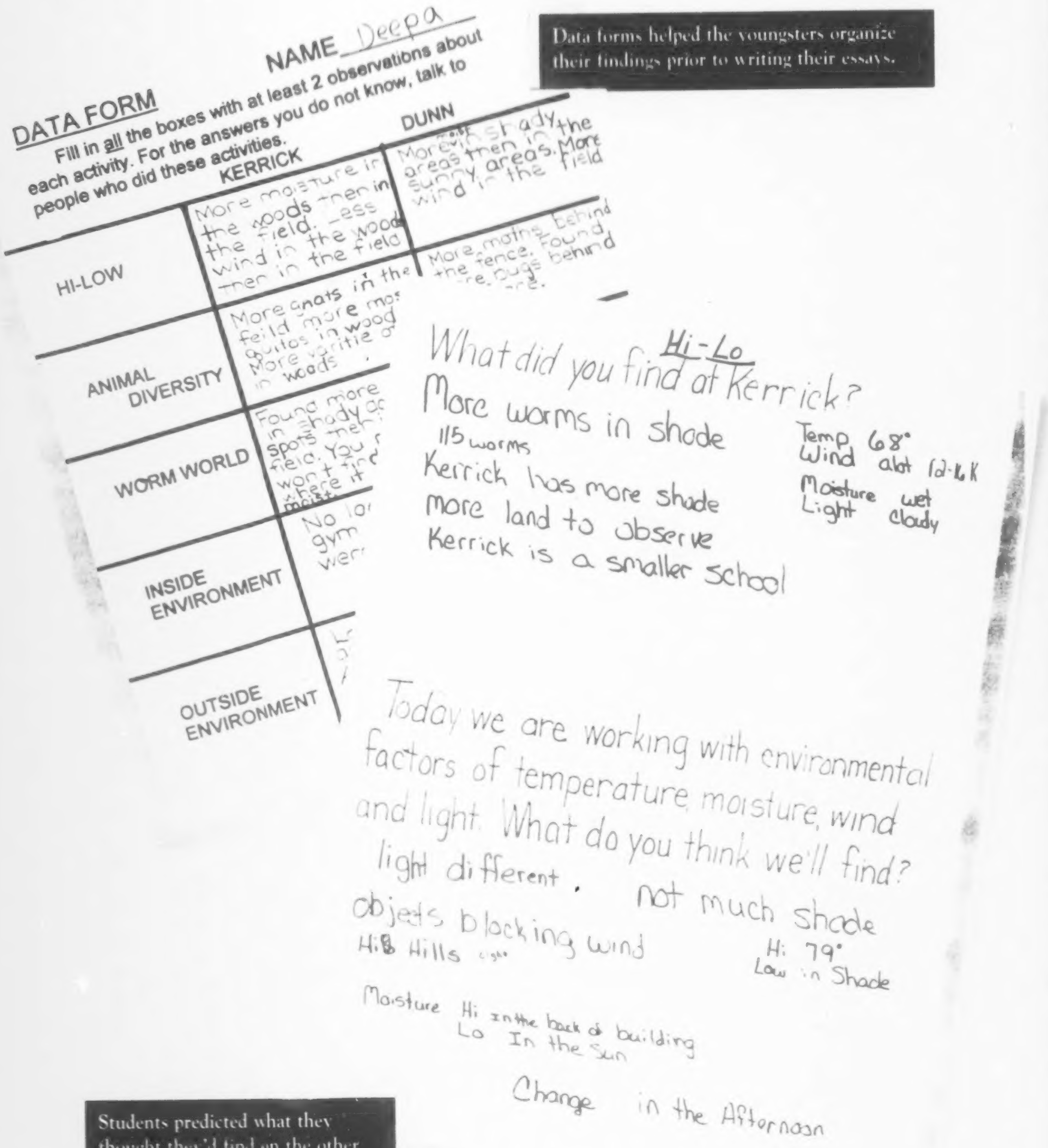
In addition, the team agreed on goals, reflection writing assessments, and scoring guides for students' use of time and small group interactions. Finally, plans were made that delineated responsibilities and logistics for all the team members, students, volunteers, and others during the performance events.

Students become experts in investigating environmental factors, the numbers of worms, and the diversity of tiny flying creatures in different schoolyard habitats.

In the weeks preceeding the performance event, students worked to become "experts" at their own schools in *one of three areas*: environmental factors, worm populations in different places, and animal diversity in a mown lawn versus an unmown or more natural habitat. (The Kentucky Team vignette on pages 19-23 describes how students developed their expertise in one classroom.) Based on their learning experiences at their home school, classes predicted what they thought they would find at the second school during the performance event. (See prediction chart on next page.) Then on the appointed day, students visited this second school and conducted outdoor investigations in two new areas led by host school "experts" (who knew both their school grounds and the specific area being investigated). This process allowed students to acquire new experiences and interact with one another to develop their understandings of environmental factors and diversity.

Back in their classrooms, small groups of students (composed of experts from all three areas) gathered together to share their understandings and experiences with one another and organize their learnings, as they completed a Data Form. (See Data Form on next page.) This gave them an opportunity to fill in gaps in their learnings and listen to their peers' explanations as they cooperatively culled what they had learned. Finally, students were given the individual writing assessment, wrote responses explaining all they had learned and now understood about "What affects the plant and animal life in our schoolyard?", and were scored, based on the Concept Scoring Guide.

Data forms helped the youngsters organize their findings prior to writing their essays.



NAME Deepa

DATA FORM

Fill in all the boxes with at least 2 observations about each activity. For the answers you do not know, talk to people who did these activities.

	KERRICK	DUNN
HI-LOW	More moisture in the woods then in the field. Less wind in the woods then in the field	More ~~moist~~ in shady the areas then in sunny areas. More wind in the field
ANIMAL DIVERSITY	More gnats in the feild more mos quitos in wood More varitie o in woods	More moths behind the fence. Found bugs behind
WORM WORLD	Found more in shady a spots then i field. You won't find where it moist	
INSIDE ENVIRONMENT	No lo gym wer	
OUTSIDE ENVIRONMENT		

Hi-Lo

What did you find at Kerrick?

More worms in shade

115 worms

Kerrick has more shade

more land to observe

Kerrick is a smaller school

Temp 68°

Wind abt 12-16 K

Moisture wet

Light cloudy

Today we are working with environmental factors of temperature, moisture, wind and light. What do you think we'll find?

light different. not much shade

objects blocking wind

Hi~~B~~ Hills light

Hi 79°

Low in Shade

Moisture Hi in the back of building

Lo In the Sun

Change in the Afternoon

Students predicted what they thought they'd find on the other school's grounds.

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In June, as the team reflected on its efforts, members agreed that their performance events and the March 23 meeting were their "most important days" in the sixteen months they had worked together. They reported: "On March 23, the team product/performance event really began to take shape. We began to see how previous activities had prepared us for the finale. What had been individual lessons started to fit together as an overall learning experience for students. Individual visions were compromised in order to form the team vision ... and enable kids to perform and learn to their full potential."

"I have come to believe completely in the teaching of science through real experiences as opposed to using a textbook. It is the only method that makes sense to me now. Why should students read about science when they can do science? I was surprised at how much fun science could be and how easy to integrate into other areas of the curriculum. The planning was much more time consuming than I expected, but I enjoyed working in a team."

The team members agreed that they'd learned much. They also agreed that the students in the VINE Follow-Through classes were more motivated in science class than those in the control groups and had learned more. One question on the state assessment for grade 4 asked students about the components of soil – content relevant to this program. Perhaps, they thought, by comparing the performance of students in the two fourth grade VINE Follow-Through (experimental) classes and in the two control classes (in a school with matched socioeconomic characteristics), they could see a difference. In 1997–98, when the results were released, they found that the experimental group had **no** novice answers, but the control group did. In addition, the experimental group had more students in the apprentice-proficient range. Team members regretted they had not done pre- and post- tests with the students in this project rather than, as an afterthought, just looking at results for one state question that happened to relate to their content. But the results did bolster their observations that participating students were more enthusiastic about learning the material and sharing it with their peers and had gained both science concepts and skills as well as communication skills.

The Seattle Team's Story

During the Summer Institute, the Seattle Design Team had shared its first-year learnings with the teams from Florida, Kentucky, and the ten new teachers from Seattle. The Design Team had helped Institute participants to understand the team building process and facilitated the growth of everyone's understanding of constructivist learning. Yet, the various crises that each team would encounter during the forthcoming year could not be anticipated. It would be in the handling of these crises that the value of "teamness" would be brought into focus. Even the Seattle Design Team, which had weathered the ups and downs of a first year, encountered new and unfamiliar crises that threatened its operation during the second year.

Confronting Overwhelming Complications

At the first meeting of the second year of working together, the teachers on the Design Team voiced frustration. They were feeling **overwhelmed with additional responsibilities** placed upon them by Seattle's new superintendent. All Design Team members were feeling somewhat anxious about the district reorganization that had replaced Bob, the well-liked liaison to the central office, with Terri, whom they did not know. There was also confusion as to what the Design Team would do during its second year as it tried to work with the ten new teachers who were supposed to form a second team from the Seattle School District. But before the Design Team could begin to work on these tough issues, teammate Susan tearfully announced her **resignation from the team.**

In stunned silence, her teammates listened as she described the heart surgery her daughter was facing. Understandably, Susan's concern for her daughter and the time she would spend helping her daughter recover took precedence over her commitment to the work of the Design Team. She would have neither the time nor the energy to attend the Design Team's meetings nor the additional meetings they had scheduled with the new teachers. Filled with emotion, teammates listened to Susan as she read a letter of resignation she was planning to submit to Karen, the VINE Follow-Through project director at NAAEE. Sorrowfully they comforted her, compassionately accepted her resignation, and wished the best for her daughter.

Greatly subdued, the Design Team began to work on the other issues before it. Time was a major focus of concern. All the teachers were facing new tasks and accountability procedures mandated by the incoming superintendent. Some of the teachers were teaching a different grade and had to prepare unfamiliar curricula. The state had developed a reform agenda placing new expectations and additional pressures on teachers. Classroom conditions were difficult for all the teachers. Some classrooms had up to thirty-four students and not enough books; in other classrooms, eighteen different first languages were spoken. Non-teacher teammates could only listen sympathetically as the teachers told their stories.

RED FLAG!

Many crises, challenged our teams. You can never be completely ready for crises heading your way, but keep in mind that strong teams mean that individuals gladly support one another through team crises.

In addition, frustration and uncertainty over the team's goals surfaced. What was the Design Team's purpose this year? The previous year, teammates had worked hard trying out various Follow-Through activities with their students, celebrating successes, and learning from less successful activities. The goals of the previous year had been met: to develop follow-through activities, to develop into an effective team, and to prepare and deliver a Summer Institute. Even though the Design Team had developed a new goal during the Summer Institute, the **goal now seemed vague** and not clearly articulated. Additionally, the Design Team did not fully understand its relationship to the new teachers. There seemed to be role and responsibility confusion. Should the Design Team continue to try out various Follow-Through activities? Were team members to act as support and encouragement as the new teachers tried out activities? Was the Design Team supposed to do all it had done the previous year and, on top of everything else, facilitate the development of the new Seattle team?

Anxieties about whether the Design Team could actually continue to function as the highly effective team it had become during its first year compounded these frustrations. Familiar and **trusted teammates were gone**. Bob had been replaced by Terri. Would she have access to the same resources and people they needed? Amy, the Design Team's coordinator from the first year, had been replaced by Heather, who was just being introduced.

Originally five teachers were on the Design Team. One teacher had retired; another had gone on sabbatical. Now with the resignation of Susan, only Mark and Kristi were left. And Kristi was feeling so frustrated and overloaded that she was, as she put it, "just a millimeter away from resigning" as well. If Kristi resigned, how could the Design Team possibly do its work, whatever that was, with just one remaining teacher? The perspectives of the teachers were so important that the loss of its teachers plunged the Design Team into despair. The Design Team was disintegrating. Finally, Carole proposed trying to "off-load items from overloaded plates" to see if that would help with the time issue. The teachers agreed to try to streamline evaluation techniques from Jean, the VINE Follow-Through evaluator. What were other ways to reduce load?

Establishing Clearer, More Manageable Goals

Team members said that there were **too many meetings.** They could perhaps halve the number of scheduled meetings by holding meetings with the new teachers and among themselves at the same time. This necessitated a new way of thinking about working with the new teachers. Mark suggested that rather than the Design Team trying other new things, its members could become "advisors/encouragers/supporters" to the ten new teachers, listening to *their* success stories. This offered a new role, different from last year's, and a new direction for professional development. Anita suggested that perhaps, because of the reduced numbers of teachers in the Design Team, they should no longer talk about the "the Design Team" and the "ten teachers," but that they should *all* be considered the "Seattle Team." This idea was quickly embraced.

Everyone became excited about the **new directions and roles** being developed. A **renewed sense of purpose** emerged because there was a new reason for *being* a team. By including the ten new teachers in the "Seattle Team," there would still be a critical mass of teachers participating. Unknown was whether the new teachers would even *want* to become part of the *new* Seattle Team. An upcoming meeting would be the perfect forum at which the concept would be presented. If the ten teachers liked the idea of merging with the Design Team, the new Seattle Team would together formulate a common team goal.

TEAM BUILDING TIP

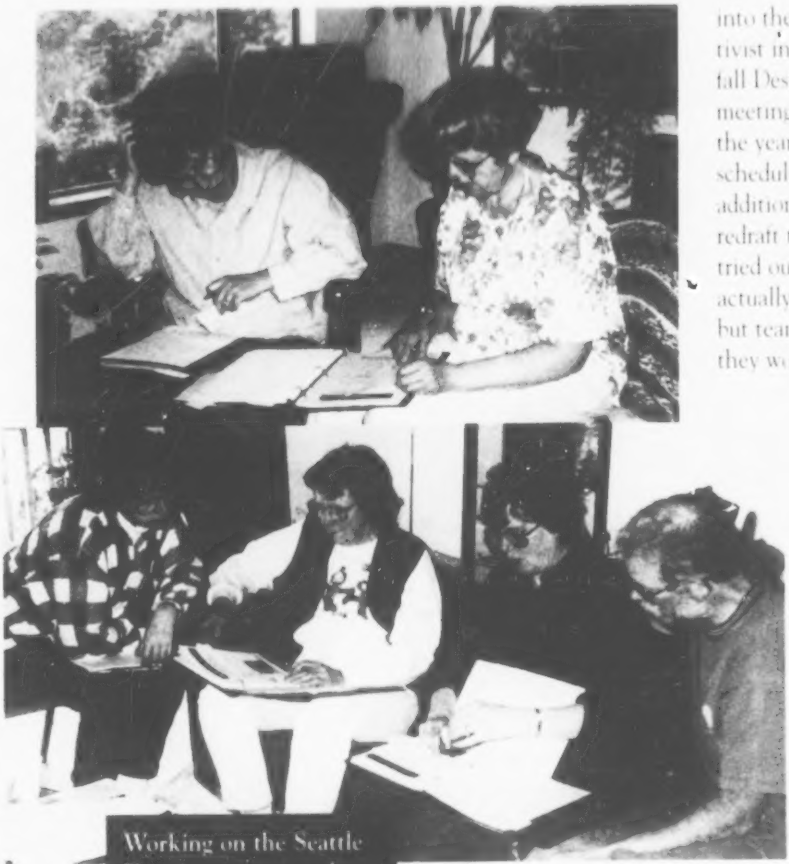
A team's goal cannot be decided by one or two individuals. In order for all team members to "buy in," the goal must be reached by consensus and understood by all.

Now they all felt that they had worked through several crucial issues. There was great relief that the workload had been reduced (at least it *seemed* to have been reduced). Susan, who had remained through the meeting to participate in the discussion, was feeling better. As the meeting ended, she hugged everyone and left saying that she might reconsider her resignation in light of the reduced pressure.

At the subsequent meeting with the new teachers, all decided that a merger was a good idea. As Anita had suggested, a **new Seattle Team** evolved whose **common goal** became the development of a Resource Book of suggestions for teachers on how to make their VINE Program experiences more integrated

The Seattle Team (L to R)

Bob- District's science specialist; Eisenhower Funds coordinator through 1994-5.
Brian- Teaches third and fourth grade.
Kristi- Teaches fourth grade.
Carole- Teaches K-8 science education at local university.
Martha- Assistant coordinator of local VINE Program.
Mabel- Teaches fourth grade.
Amy- Master's in Education student; team coordinator 1994-5.
Mark- Teaches third and fourth grade.
Susan- Teaches fourth grade.
Heather- Master's in Education student; team coordinator 1995-6.
Terri- Science lead teacher; Eisenhower Funds coordinator beginning 1995.
Japhy- Teaches first and fourth grades.
Marilynn- Teaches fourth grade.
Anita- Local VINE Program coordinator.



Working on the Seattle Team's common goal, the development of a Resource Book

into the classroom curriculum and more constructivist in orientation. During the initial, traumatic fall Design Team meeting, the number of team meetings planned had been reduced by half, but as the year progressed, everyone saw the need to schedule more meetings. All understood that these additional meetings were needed to draft and redraft the Resource Book as various strategies were tried out with students. The number of meetings actually held were *more* than originally scheduled, but teammates gladly took the time to attend as they worked to complete the Resource Book. The Resource Book debuted at a spring reception hosted by the team for all the other Seattle teachers involved in Seattle Audubon's VINE Program.

Susan, who had reconsidered her resignation, remained on the Seattle Team to assist with the achievement of the new goal. And her daughter recovered from heart surgery.

Summary

The experiences of the members of the three teams were similar. As they pursued their goal during the school year, each team

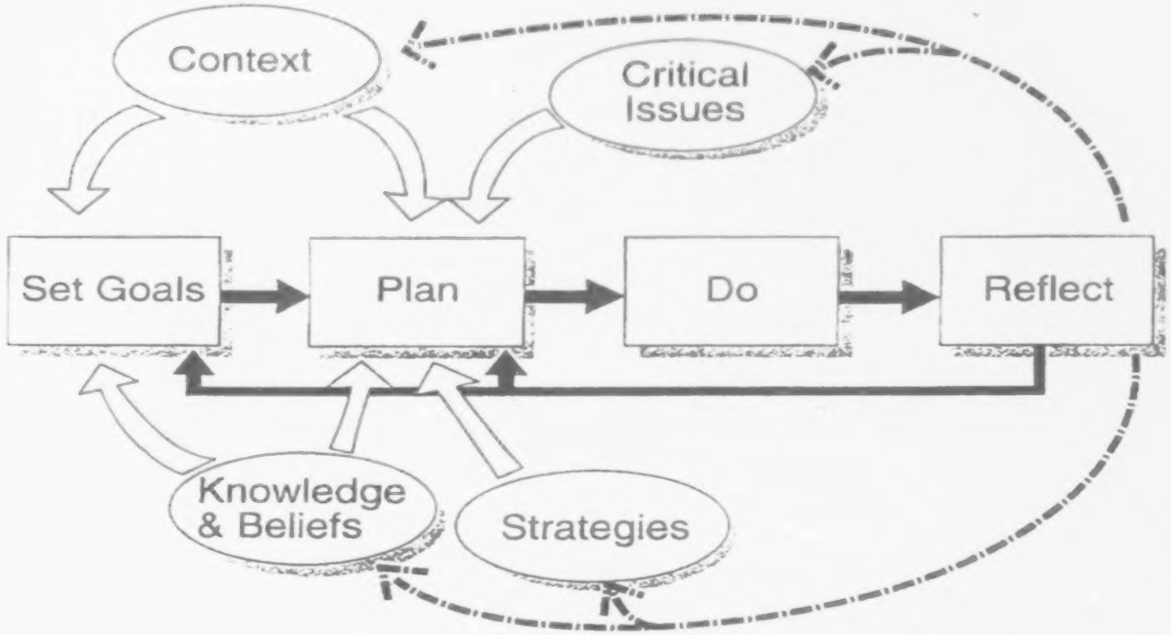
- **developed a deeper understanding of how different this sort of professional development was** from previous inservices. As one team member put it: "What we do at team meetings is so classroom-based, it's great. We get a chance to think about what we've been doing and figure out what we can do next, differently to improve student learning." When each team's schedules, meeting minutes, products, and other artifacts were analyzed, a consistent pattern emerged. Team members would decide what they needed to do next: either collectively address a need (e.g., how can we do that with our classes?) or delegate specific tasks to individuals or groups (e.g., Claudia and I will put a draft together); try out the new approaches and ideas with their classes; and then compare and reflect on their responses and those of their students and colleagues. Then they would repeat the process. Teams typically cycled through this process in a few weeks as they moved from a team meeting, to their classes, and back to the next team meeting. But when they were trying to come to grips with a bigger question or need (such as the Kentucky Team's efforts to define the content and develop a plan for its performance event), the team's struggle, breakthrough, and achievement of its goal could take months. After detecting this pattern, which had evolved in parallel in each of the teams, we were pleasantly surprised to see the "design process" model of professional development that Karen Worth projected on the screen during a 1997 NSTA Conference presentation (Loucks-Horsley, et al., 1998). We could see that the design process model (shown below) described what we were doing!

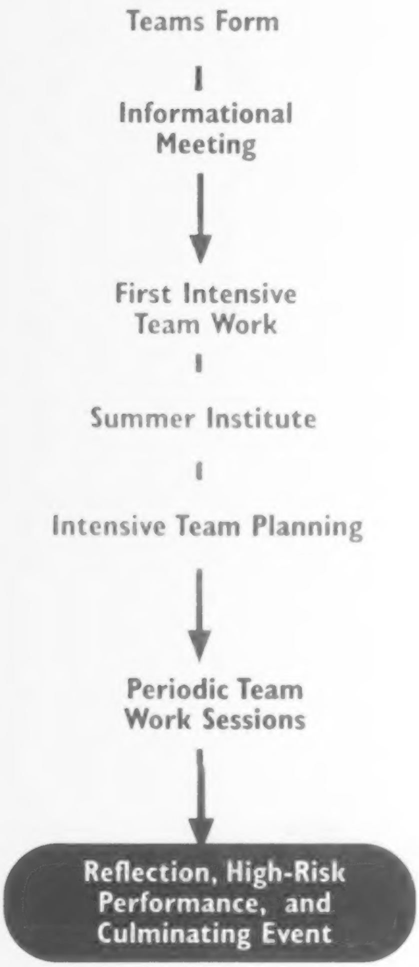
- was faced with unique situations or crises that threatened the team's progress. Getting stuck, losing resources, turnover of central office supporters, new mandates from central administration: these crises were facts of life and challenged the teams over and over again. Because the teams had spent time building themselves into strong teams, they managed to **face the crises as a trusting, cohesive unit** and continued to **work towards their common goals**. While the crises that hit the Seattle Design Team were perhaps more traumatic than those that hit the Florida and Kentucky Teams, the maturity of the Seattle Design Team and level of trust established during the first year, allowed team members to move through a very difficult period, embrace new members, and set a new goal.

- began **providing students with learning experiences that were increasingly student-centered** rather than teacher-directed. These experiences provided opportunities for youngsters to ask questions, make decisions, and assess their progress (the same process that the teachers themselves were experiencing!). Additionally, these experiences were more focused on the **development of conceptual understandings and skills over time**, rather than on the outcomes of specific individual activities.

Professional Development Design Process

for Mathematics and Science Education Reform

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REFLECTING AND SHARING WITH OTHERS

The following section describes a team's reflection on the school year and preparation for the second Summer Institute. How had team members grown and what had they learned? How will they decide what is important to share? What happened during the 1996 Summer Institute and how did it lead to new, deeper understandings and further the teams' efforts?

After each of the teams had worked together in the 1995-96 school year, they all gathered again for a second Summer Institute in 1996. The nature of this Institute was very different than the first, because the teams, which had been in the process of forming and defining their goals the previous summer, were now eager to share their accomplishments and compare their experiences. In addition, at the second summer gathering, the teams would apply the skills and understandings they had developed during the year to collectively create some new products and plans.

Each team had three days of paid time allocated for its members to prepare for the second Summer Institute. The project director, in consultation with representatives from each team and the Advisory Committee, created a set of guidelines to focus the efforts of each team and lead them in coming to the Institute with common expectations. Each team would examine both the degree to which it had achieved its goal and the value of the team in accomplishing its achievements. They would spend time both reflecting on their year's efforts and preparing an Exhibition/Performance to tell their story and demonstrate what they now knew and were able to do.

The only constraint, which everyone agreed to, was that each team would be limited to two hours for its Exhibition/Performance. Other

Points to Address in Compiling Your Team's Story

Please include:

- the process of team formation (what worked, significant points, indicators of success),
- the product(s) of your team (your team's goal and main product(s), plus selected products of special significance, and how your product(s) have helped meet district/state/national standards and requirements and have impacted students), and
- personal changes in philosophy, knowledge and/or behavior that have been promoted by this project/your team.

than that, each team decided its own format and content. The teams spent the majority of their three pre-Institute days reflecting on their individual experiences and accomplishments, as well as those of their team. The few products requested by the project director, for reporting purposes, were related to this overall task.

The South Florida Team's Story

The South Florida Team chose to "retreat" to Joyce's country home over a weekend near the end of the school year to begin this phase of its work.

The group started its deliberations with a very open, candid discussion. Each team member, in turn, explained what each of the others had contributed to her own professional growth during the year and to the professional development of the group as a whole. The discussion itself and the sincere, egalitarian, and respectful atmosphere in which it took place demonstrated how far the team had come. The difficulties in understanding one another's views and perspectives that had punctuated some of the meetings ten months earlier were nonexistent.

"In our 'becoming' a team, we have roughed up our smooth edges and smoothed out our rough edges and become new individuals."

As Barb, the team's facilitator, stated, "At first we just came together to 'do a job' – plan strategies for outdoor programs – and then we found the becoming of the team was the essential first step! These relationships will be lifelong." Several themes kept recurring in the team's reflective discussions and subsequent journal writings. The team members said they had **"learned to really listen"** to each other and to share openly. They felt that they had gone beyond their preconceived notions of one another based on job titles and **learned to value one another as people with different roles and skills**. They felt **highly motivated to work together**, pursue their goal, and help one another succeed. The team members felt they had "gained a tremendous amount of knowledge regarding **the effects of the students' different economic and cultural backgrounds**." Other team members' comments reflected their changed perspectives: "When our team shared how individual students and classes acted/reacted differently to the same activity, it was truly fascinating!"
"It got us all thinking about and gaining **insights regarding different teaching/learning approaches and classroom structure/management styles**."
"We found ourselves breaking down barriers/preconceived notions and **gaining more understanding about others** – what they are up against personally, professionally, and in their individual schools or workplaces....The thoughtful reflection spilled over into our everyday professional lives."

TEAM BUILDING TIP

Creating a psychologically safe environment encourages team members to see themselves and others differently, to take risks, to share openly, and to persevere through change and unfamiliar roles.

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A DISTRICT OFFICE PERSPECTIVE

Science curriculum supervisors are generally administrators who write curriculum, inservice teachers in how to deliver the curriculum, and strictly adhere to the job description that states "and will perform all other duties as requested." Occasionally, they are asked to visit a classroom and model a science lesson. Contact with the classroom teacher is sporadic and fleeting.

Then along came VINE Follow-Through. What a unique opportunity to work directly with classroom teachers for an extended period of time! I was excited but wondered if I would be perceived as *that District Person.* (You know, the one about whom everyone says, "What does she do in that office all day?" or "Don't they do anything in that office?" or "I wish I had that cushy job!")

My fears were soon abandoned when I met the VINE Follow-Through participants that were selected for our team. All were extremely dedicated, creative, humorous, and wanted to do what was best for all children. All came from different locations in the District which brought a great diversity to this project. Each brought his or her own strengths and expertise. And each was not sure about *that District Person.*

It took some team building strategies, social outings, and school visits to build the trust that was needed for all of us to work together. Over these three years we've been through births and deaths, good times, and not so good times. The end result was worth the efforts, the risks, and the added work. A strong support group was formed and friendships developed and flourished. All were accepted for what they were, not who they were. I was not *that District Person* any longer but an equal peer. **And I like that!!**

A TEAM FACILITATOR'S PERSPECTIVE

The primary role I played on the team was as a facilitator. But this was a very different kind of facilitator role than I was used to because I wasn't standing in front of the room, facilitating an inservice – I was part of the team. I found that I was guiding the group in the difficult process of team building by becoming an equal member of the team. This meant I had to lose my "distance" but still retain a level of objectivity to fulfill the facilitator role. Sometimes I kept the team on target, even when the vision wasn't always clear for us, by assisting the team to identify the steps we needed to take to clarify our vision.

I felt I was facilitating our team by bringing out the strengths of individual team members and helping them to work through their needs. I often reminded the team of what we HAD accomplished when we felt we were stuck and not going anywhere.

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The Team's Impact on Classroom Instruction

As the discussion turned from the team's functioning and what teammates had gained from one another to the products that had resulted, several people mentioned that the team had enabled them to **gain a deeper understanding of constructivism, both in terms of what it is and how to foster it.** Just as the team's collective efforts to listen and learn from one another had enabled members to develop new group skills and pedagogical insights, the opportunities to discuss various ways of pursuing their goal, plan teaching/learning strategies, implement them in different schools and classrooms, and assess the outcomes had enabled them to experiment with and change what they did. With the support and encouragement of their colleagues, teachers tried new things with their classes. The university, school district, and nonformal educators also changed what they did: rather than "telling" teachers what to do, they spent more time observing classes, listening to others express ideas, assessing individual needs, asking questions, and suggesting or providing resources.

Moving from Teacher-Driven to Student-Centered Classrooms

As the team looked back at the year, the members clearly saw a pattern. In the fall, the team tended to examine the VINE investigations and the science process skills, and select teacher-directed activities designed to build student skills. By December, the team realized that many of its plans and activities were teacher-driven. They challenged themselves to turn around what they were doing and make it more student-centered – and to create the kind of safe classroom environment that would enable the youngsters to ask questions, make decisions, and take more control of their own learning.

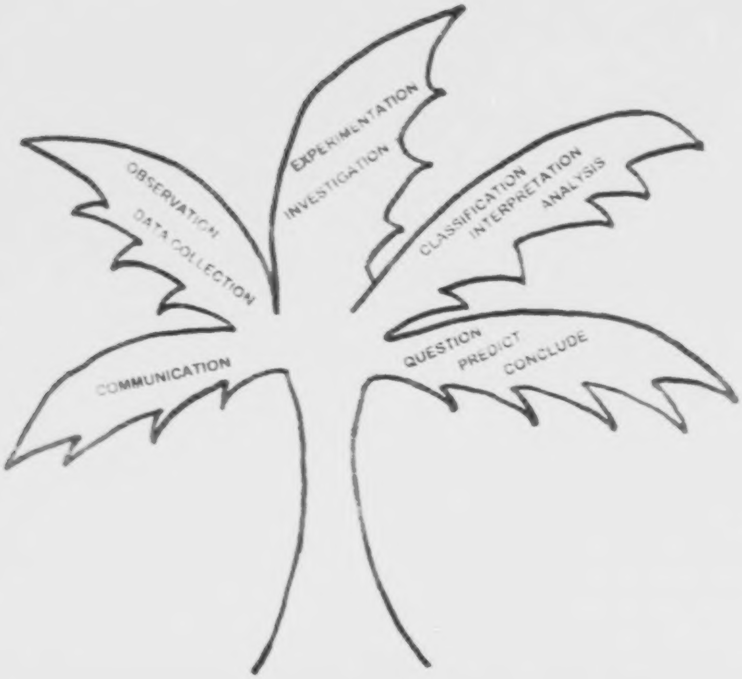
Just as the team felt they were making significant progress towards creating constructivist classrooms, they were faced with the crisis described in the adjacent box. It was unexpected and disturbing. But, similar to the way in which the team had grown to face teaching/learning challenges together, teammates responded supportively to Karin's plight.

The South Florida Team Faces a Crisis

City newspapers broadcast the latest academic scores comparing student achievement in the Broward County Public Schools. Karin 's school lands on the "low academic achievement" hot list and the school faces an immediate crisis. Intense pressure is applied to improve student performance and teachers at the school are told that they are to focus on only the basics: reading, writing, and arithmetic. The number of minutes they are to spend on each subject is mandated and it computes to more minutes mandated than there are minutes available in the school day – unless the students forego recess and lunch! She is told that if she wants to do science, it must somehow "fit in."

Karin tells the team that she can no longer participate in the VINE Follow-Through Project since she can no longer teach hands-on science. She knows that she will not be able to trial test the various activities developed by the team and fears she will not be a contributing team member. Her teammates listen sympathetically but tell her that her ideas are valuable to them all. They want her to remain on the team even if she doesn't have the opportunity to trial test activities; it is Karin – her knowledge, skills, and understandings – that they value and need.

By the end of this emotional meeting, Karin has decided to remain on the team. During the year, she is able to work in some of the VINE Follow-Through activities by integrating them into the arithmetic and writing curriculum. By the end of the year, her school has more lenient limitations. Karin has even persuaded other fourth and fifth grade teachers in her school to join her in building on the VINE investigations. And, better yet, she has obtained financial support from her school and district to support after-hours meetings of a VINE Follow-Through professional development team within her school! Karin becomes the facilitator! This project continues to succeed in several other classes now, including special education.



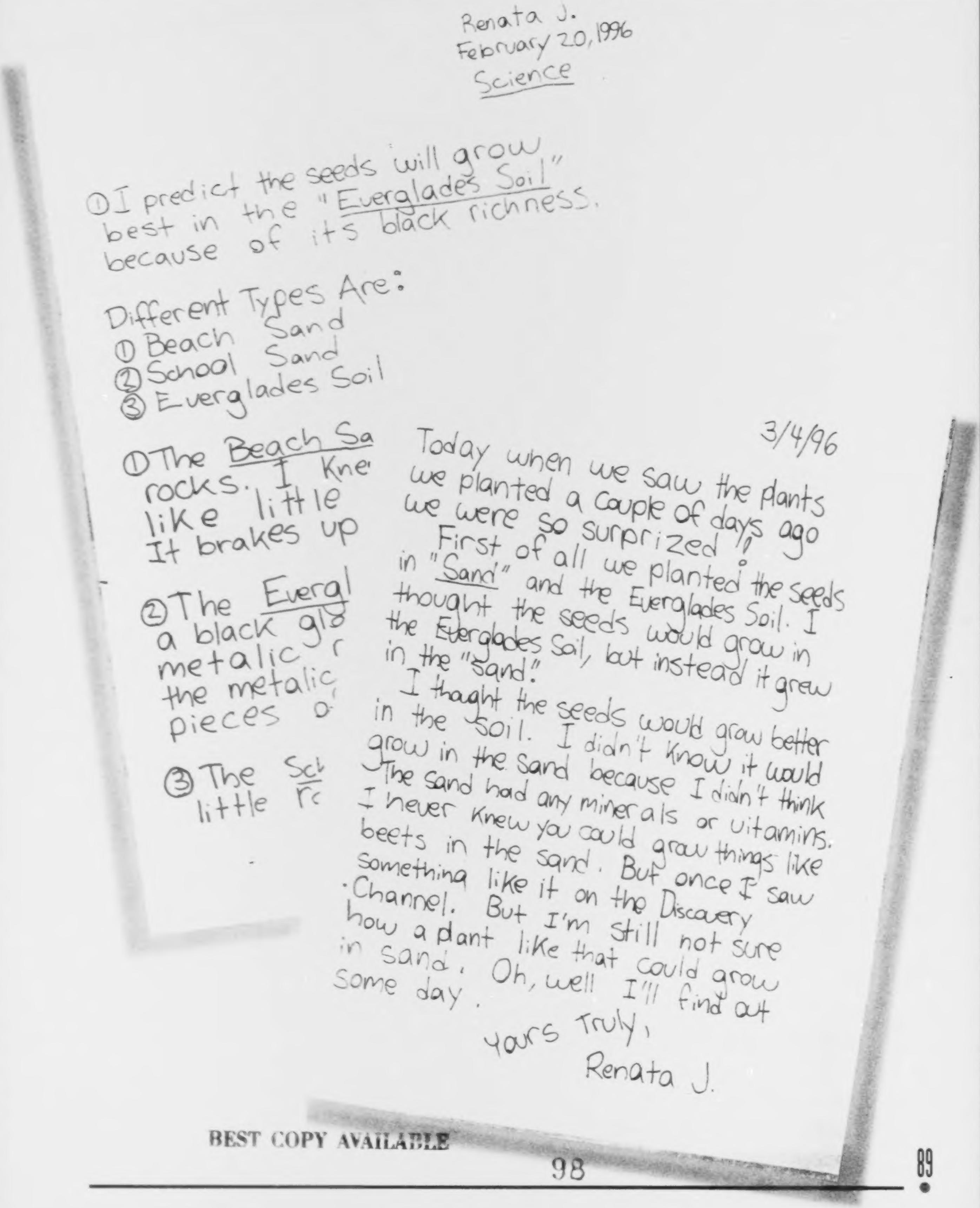
The South Florida Team's Palm Tree

Focusing on the Students

When team members started **assessing students' prior knowledge** (using brainstorming and carousel mapping techniques, in which each group adds to the ideas of others), they discovered how much their students already knew! And, following the *Super Soil* investigation (OBIS 1980), when the students were asked to design experiments to find out in which soil seeds would grow fastest, the **teachers found that students already had some good ideas and were eager to predict the outcomes**. By having students write their predictions in journals and compare those predictions with their actual findings, teachers found that some students were quite surprised. (See one example on the next page.) Rather than giving the students a chart on which to collect data, teachers asked youngsters to brainstorm data they might collect, make decisions about what to record, and design a chart for themselves – with the students learning a lot in the process. The teachers also learned more about their pupils' understanding of charts and measurement skills – and integrated this inquiry with their mathematics unit on metric measurements and charts.

By the spring, the team had learned that one of the most important parts of lesson planning was the **creation of open-ended prompts for students**, and they helped one another in wording these prompts. As the teachers' and students' skills and confidence grew, the lessons changed. By the time they began preparing for the spring investigation of *Animals in a Grassland* (OBIS, 1982), students were writing predictions in their journals about what they thought they would find in their schoolyard, comparing their predictions with their results, and generating their own wonder questions about the tiny creatures they found. For their part, the teachers were finding more and more ways that they could weave the development and application of the students' science process skills into their curriculum in an interdisciplinary manner, and were building on the students' interest and ownership in the topics they were investigating.

"The collegiality... would not let me be self-satisfied - or quit."



Renata J.
February 20, 1996
Science

① I predict the seeds will grow best in the "Everglades Soil" because of its black richness.

Different Types Are:
① Beach Sand
② School Sand
③ Everglades Soil

① The Beach Sa
rocks. I Kne
like little
It brakes up

② The Everal
a black gl
metalic r
the metalic
pieces o

③ The Sc
little r

3/4/96

Today when we saw the plants we planted a couple of days ago we were so surprized!
First of all we planted the seeds in "Sand" and the Everglades Soil. I thought the seeds would grow in the Everglades Soil, but instead it grew in the "sand."
I thaught the seeds would grow better in the soil. I didn't know it would grow in the sand because I didn't think the sand had any minerals or vitamins. I never knew you could grow things like beets in the sand. But once I saw something like it on the Discovery Channel. But I'm still not sure how a plant like that could grow in sand. Oh, well I'll find out some day.

Yours Truly,
Renata J.

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3/6/96

The Gator Beans: The beans grew best in the School Sand and The Everglades, Plus the Beach Sand too. The Reason I think they could grow So well is because of the Seed and it was correctly watered too.

The Raddish: The Raddish seeds grew best in the school Sand only because it was watered correctly. The seeds in the Beach Sand are dieing because they don't have enough water. But the Everglades Soil isn't letting it grow because it has too much water in it.

The Sunflowers: The Beach Sand and the Sunflower Seeds are doing just fine, and So is the school Sand. But again it is flooded with water in the Everglades Soil.

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To convey to the rest of the teams the ways in which they changed their teaching, the team decided to assemble a binder. Each schoolyard investigation would be accompanied by

(1) the Sunshine State Standards and science process skills it addressed,

(2) the teaching/learning strategies used to integrate the investigation into the ongoing curriculum, and

(3) student products.

The binder would highlight the progression towards more constructivist practices as well as the impacts those practices had on the development of student skills. It would show that the team was meeting its goals.

The Power of the Team

The highlight of the professional development experience for the South Florida Team was the fact that it had been able to evolve into such a high performance team. That was the centerpiece of their Exhibition. They would showcase their team by once again using a palm tree analogy and featuring the different **roles** that they each took on – roles that they had come to understand and value so highly. Barb's pivotal role as facilitator/teambuilder was recognized and honored as the "trunk"; other non-teacher members became the "coconuts" because of their role in planting seeds; and the teachers became the "fronds" that implemented the team-designed strategies and developed students' science process skills. All these roles and people were necessary to make the tree whole – to make the team complete – and, once together, **the power of the team** created the safe environment in which they each could try new things and grow.

OUR IMPORTANT BOOK

The South Florida Team showed that, because they had been willing to listen, assimilate others' ideas, change, and evolve with their teammates, they were confident enough individually and collectively to take on anything...and could have fun doing it"

"To learn what we did, you must be a part of it. You can't just 'teach' it in an inservice workshop."

As they discussed ways to extend this experience and involve additional teachers in their district, it was clear that they had a new understanding of professional development. They envisioned an approach that would enable them to work with colleagues from their school, beginning with a workshop to introduce the Follow-Through concept. They hoped to access release time that would allow new teachers to observe team teachers as they worked with students and to discuss the teacher-student interactions they had observed. By offering opportunities for new building-level teams to work with Follow-Through Team members, they hoped to enable new teachers to plan, implement, and assess new ways of building their students' schoolyard investigations into their curriculum.

* * * * *

The teams from Kentucky and Seattle also spent considerable time reviewing and reflecting on their efforts of the past year and contemplating next steps, and each of the teams arrived in Seattle for its second Summer Institute prepared to present its achievements. The Kentucky Team produced a video, which included footage of their students' culminating events and interviews with students about what they had learned. They also organized a presentation under the headings of Forming, Storming, Norming, and Performing to show the stages their team had gone through in becoming a team and achieving its goal — and for fun, they led the entire group in singing "Funky Herman."

The Seattle Team modeled its presentation after a television newscast and used individual stories to highlight the ups and downs that they experienced as they worked toward their goal. In a binder, they exhibited the collection of lead-in and follow-through activities they had assembled to assess students' initial skills and understandings and to help students build conceptual understandings following their outdoor investigations. They asked all participants to review the binder's contents and give them feedback for its improvement.

While each team highlighted what became labeled "the importance of teamness," each also featured somewhat different elements that corresponded to the team's local challenges. Seattle had dilemmas that stemmed from the expansion of its team and the desire to make the ten new teachers an integral part of the team, the medical needs of a team member's daughter, and the new superintendent of schools and corresponding changes in their system. Kentucky's pride in pulling off what was by all accounts a fabulous performance event contrasted with ongoing deliberations about how to expand and institutionalize the program. The fact that each team had risen to the challenge in the face of formidable obstacles, achieved its goal, and was pleased with its accomplishments set the stage for the week.

* * * * *

At the final Summer Institute, Seattle, Florida and Kentucky educators compared their learnings and the similiarities of their teams.

The rest of the Institute focused on tasks that drew on and built upon the collective experiences of all teams. The participants

- learned what the external evaluators had found and discussed the findings;
- reflected on and distilled cross-team learnings – for example, how non-teachers grew as a result of this project and which roles were essential for the smooth functioning of each team; and
- looked to the future, with each team planning ways in which it could extend and expand its efforts in its respective district, and interested members of all three teams discussed plans to present sessions at educational conferences.

The products of these deliberations are included throughout *Changing What We Do,* underscoring the fact that this publication is the result of the efforts of the many people listed on page ii.

Summary

The teams' efforts in the VINE Follow-Through Project ended with three interrelated opportunities to distill what they had gained:

- A **time set aside at the end of the year** for **reflective thinking** by both individuals and the team. This helped participants develop new understandings regarding professional development and constructivist teaching/learning. The Exhibition/Performance focused team members on ways to **demonstrate and articulate what they had learned;**
- A culminating Summer Institute at which teams showcased their work for others, **celebrated** their progress, worked together in cross-team groups to **distill additional learnings** from their experiences, and worked with their teammates in **setting a new goal and planning for the next year**; and
- Individual and collective efforts to create parts of this publication. This final effort was driven by the interest many participants had in **sharing what they had done and learned with a broader audience**.

Leadership Development

The notion of **egalitarian leadership** within the teams was unique for VINE Follow-Through participants. The team facilitators were not team "leaders" in the traditional sense of the word. University faculty were not the "leaders." Though they might have had more sophisticated understanding of adult learning than others, they did not possess the deep understanding of classrooms that teachers had. Classroom teachers were not the "leaders"; they simply didn't have the time! Nonformal educators were not the "leaders"; their special understanding was the VINE programs they were offering to the schools. Even though district science specialists had much experience with teacher inservice and curriculum development planning, **this was a "problem-centered project" involving many different kinds of people.** Thus, science supervisors were not the "leaders." As one non-teacher team member put it, "This time we didn't 'do something to teachers' or 'give teachers something,' we worked **with** teachers and other education professionals."

This was a "problem-centered project" ***with*** **teachers and others, not a "delivery project" to teachers and others.**

So who was leading the VINE Follow-Through professional development experience? In short, everyone — at different times. But teams had to make sure that all were facing in the same direction, moving toward the same goals. As different individuals took the lead for different purposes, the team would continue to move forward toward the achievement of its goal.

In this section we provide some examples of leadership development, how it happened, and the results.

PLANNING A SUMMER INSTITUTE

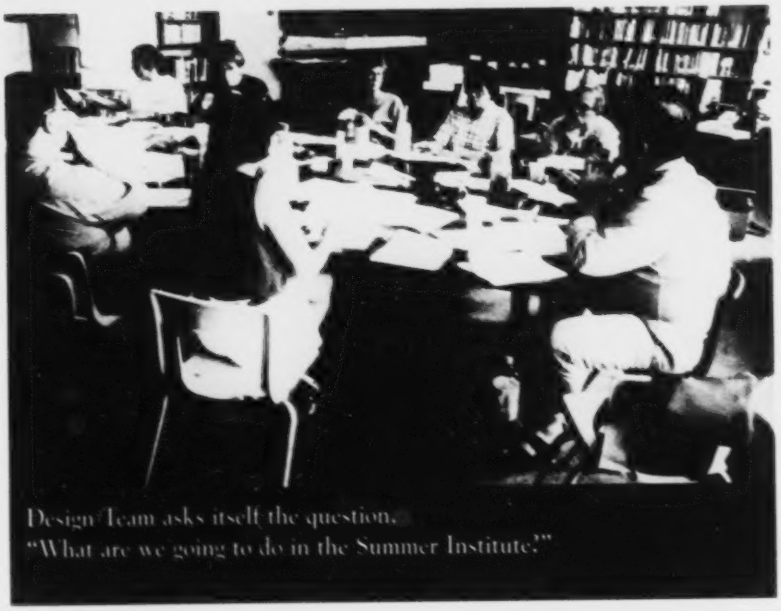
The high-risk performance that culminated the Seattle Design Team's first year's work was to plan and prepare the Summer Institute for the Kentucky and Florida Teams and the ten new Seattle teachers. The intensive week the team spent planning the Institute proved to be a challenging, and initially unsettling, professional development experience for many of the Design Team members who recognized that now *they* were to be the "leaders" facilitating the professional development of *others*. The Design Team had had many experiences during the previous summer and academic year. Deciding exactly what to share, how to share it, and how to build teams was difficult. At first, the tendency was to fall back into old habits of professional development. "Let's *tell* them what we know and *show* them what to do."

As Fullan and Stiegelbauer suggested, this task required the team to "actively initiate a plan with both pressure and support" – one of the steps they envisioned as necessary in "changing the culture of learning for both adults and students."

Carole reminded the team that the value of the past year was partially in the construction of common understandings and strategies and not having anyone telling them what they should know or training them to do things in a particular way. In a flash everyone understood that what they needed to offer were experiences facilitating the construction of the beginnings of the same understandings that they now had. What were some of the experiences that the Design Team itself had undergone — both during its first summer together and during the ensuing year? Perhaps if those could be identified, then a better idea of what to do during the Summer Institute would emerge.

The team's the thing!

Not wanting to miss any ideas, Amy suggested that everyone write down all the ideas/strategies/activities that each felt had been important to his or her experience. Team members recorded their ideas on small "yellow stickies," which they stuck on a huge piece of butcher paper. The responses were then grouped by type. For example, several individuals recorded the importance of engaging in a team-generated investigation that first summer, which had allowed them to get to know one another while being involved in a meaningful and fun task. Those responses



Design Team asks itself the question,
"What are we going to do in the Summer Institute?"

were lumped together in one area. Others stressed the value of team work while recognizing individual and diverse perspectives, and those also were grouped together. Yet others mentioned the good conversations that occurred over lunches and refreshment breaks. As team members continued to move the "yellow stickies" around on the butcher paper, a pattern emerged, and Japhy shouted it out: "The team's thing!" Despite the fact that the team had been so important to the Design Team all year long, "teamness" needed to be pulled forward and teased out once again.

Mark suggested designing a "constructivist institute" in which the new teams would begin to construct their own understanding of "teamness" and analyze their own situations for Follow-Through activities. One of the project evaluators suggested the "4 E" learning model — Engage, Explore, Explain, Expand — as a framework for the Institute. The learning model (Appendix page H.27) helped define what was to happen and when during the five days of the Summer Institute.

The development of a "constructivist institute" was a stretching challenge for the Design Team but knowing that they would facilitate the Institute as a *team* made it less daunting. The team began to identify key pieces for the institute, among them:

- team building activities,
- an outdoor inquiry and pursuit of additional, independent queries,
- time for teams to plan their own goals,
- refreshments to keep energy levels high, and
- opportunities for informal socializing.

Team members eagerly stepped forward to be responsible for various pieces with which they felt most comfortable. Japhy, who had catering experience, volunteered to prepare the morning and afternoon refreshments. Amy, the Design Team coordinator, volunteered to coordinate late afternoon excursions like canoeing. Anita, local VINE program coordinator, volunteered to lead the outdoor inquiry. Bob, the district science supervisor, wrote an introductory scenario for the inquiry. Kristi introduced the initial team building activity. Susan volunteered to introduce the teacher sharing session. All teachers would participate in the teacher panel and bring in student products to post on the walls. Everyone would be involved in the "jobs alike" portion of the Institute. Carole volunteered to type up a detailed daily schedule on which everyone could either introduce or support activities.

"As a teacher, I feel that I've truly stepped up and delivered!! I see this week of facilitating the Institute as another step up the ladder of professional and personal growth."

The team operated like an award-winning sports team. Teammates knew and respected the skills, knowledge, and perspectives of one another. By the time the Institute opened, all team members knew what they were doing and when. They knew the schedule so well that anyone could step in for anyone else at anytime. Everyone, including those who had been anxious about "leading" the summer institute, was looking forward to fulfilling new roles. Those teammates used to "leading" sessions learned how to **share** power, responsibilities, and roles, and learned that they liked not leading!

THE PERSPECTIVE OF A NEW TEACHER LEADER

Having taught for over a decade, I've developed a certain level of competency and confidence in my ability to lead a group of youngsters through the rigors of intellectual effort in pursuit of understanding. Prior to my VINE Follow-Through experience, I had a high degree of fear and a low opinion of my ability to do the same with adult learners.

Among the most remarkable transformations this project brought me was the dismantling of this self-imposed barrier. Having experienced the collegiality, camaraderie, shared vision, and trust of the Seattle Design Team, I was able to commit myself to the collaborative design, development, and production of a week-long workshop, act as facilitator, and give presentations at five national or regional science and environmental education conferences. The process of synthesis and necessary reflection on "What are we doing?" and "Why are we doing this?" forced a deeper understanding of personal and professional development.

I no longer feel intimidated by the thought of making presentations to adult audiences. In fact, I find it exhilarating. This is one aspect of my professional growth that was an unforeseen outcome of my participation in this project.

Sharing the leadership role shifted from the idea that professional development was for teachers to the idea that professional development was for everyone. Still, the "ratcheting up" of expectations in terms of having to "lead" perhaps had the most profound effect on the teachers, who are usually on the receiving end of professional development. Teachers saw themselves in a new way and several mentioned that they felt validated as "professionals."

Various teams planned conference presentations for the National Science Teachers Association, the Association for the Education of Teachers in Science, and the North American Association for Environmental Education. In every instance, planning forced individuals to reflect on what they had done. Reflection led to new understandings on the meaning of moving away from a "training model" to a "project-based model," and on the meaning of being a professional educator.

BECOMING LEADERS

We all became involved in VINE Follow-Through because we saw a need to more closely incorporate VINE Programs into school curriculum and district goals. As our teams evolved and worked to meet this particular need, deep changes occurred in individuals. The way they had worked in VINE Follow-Through was transferred to other areas of work. The way classroom teachers, for example, worked with colleagues in other contexts besides VINE Follow-Through changed as they actively sought out opportunities to collaborate with other teachers.

These changes, of course, did not occur overnight. As stated in *Taking Charge of Change* (Hord, et al., 1987), "Change is a process, not an event." The process for the

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participants of VINE Follow-Through was at the same time frustrating and satisfying, unbalancing and enlightening: The process required that participants be followers as well as facilitators, supporters as well as leaders. How confusing!

All VINE Follow-Through teams went through periods of great turbulence. Each team would start with an initial concept of what it meant to be a "team" and what their "team goal" was and then, in the process of working through the ups and downs of team evolution towards the goal, things changed. Goals were met in different ways than initially envisioned. We began to think of this turbulent process as the "tornado effect" — the team goal was drawn into the tornado and, amidst the turbulence, individual and team "ahas" constantly spiraled the team goal upwards to transform the team goal into something bigger and better that popped out at the top. As teammates learned to trust and rely on one another in a truly collaborative setting, they began to construct a different understanding of teamwork; the common goal became more than words.

As well as a transformed goal, the "tornado effect" changed the team members themselves. Teammates helped each other through the vagaries and demands of individual jobs, took responsibility for their own learning, and supported others in their learning.

The collaborative "way of work" became a preferred method of working with colleagues. In particular, teachers habituated to working in isolation began to seek ways to reach out to other teachers. Japhy, who because of his transfer to first grade was no longer eligible for the local VINE Program, began working with his fourth-grade colleague. Japhy and his colleague developed a spin-off VINE program in which his colleague's fourth graders work outdoors in small groups with Japhy's first graders. Karin Singer not only reestablished VINE programs in her "low achievement" school, but also persuaded her principal to provide funding for regular meetings for a school-based VINE Follow-Through Team of teachers.

TEAM
GOAL
GOAL
TEAM

The "tornado effect" buffeted teams and led them to transform their goals.

Moving from self concerns to impact concerns, participant involvement in VINE Follow- Through mimicked the Stages of Concern described in the Concerns-Based Adoption Model (page 5). The chart below shows the Stages of Concern, expressions of concern during the various stages, and some typical questions and statements that participants made during their journey through the Stages as they became leaders. Although the **journey may look linear, it is not**! While participants generally moved from Stage 0 to Stage 6, the journey was more like being swirled around within a tornado. Individuals may have been swirling from one stage to another, skipping back and forth, over and through stages. In addition, because individuals were working in a team and teammates were at various stages at different times, forward progress sometimes went slowly and sometimes rapidly. Comments are included in parentheses under the Typical Questions/Statements column.

Stage of Concern	Expression of Concern	TypicalQuestions/Statements
Stage 0 Awareness	No concern about VINE programs, VINE Follow-Through programs, or their possible impact.	"What is VINE?" "What is VINE Follow-Through?" (Although the teachers and VINE coordinators knew about VINE, others such as university faculty had to enter at this very beginning stage).
Stage 1 Information	Concern focuses on seeking general details about VINE and VINE Follow-Through as well as requirements for participating.	"I'd like to know more about VINE and VINE Follow-Through." "What would I do for two years?"
Stage 2 Personal	Uncertainty about how participation will affect the individual personally and whether the incentives to participate in VINE Follow-Through are worth the uncertainty.	"If I participate in VINE Follow-Through does that mean I won't be able to use the volunteers anymore?" "What is my role within this group?" (To state it bluntly, the question of "What's in it for me?" has to be addressed first. Lofty goals are generally too abstract to get individuals to buy into a project that will require considerable time and effort with people they don't know.)
Stage 3 Management	Concerns focus on processes and tasks involved in developing Follow-Through learning experiences.	"What materials do we need to do graphing activities for VINE Follow-Through?" (Teams spent considerable time swirling around in this stage, building team relationships, working together to develop Follow-Through activities, gathering materials. They would continue to return to Stage 3 throughout VINE Follow-Through.)

Stage 4 Consequence	Concerns focus on whether Follow-Through activities are having a positive effect on student learning and how those effects can be maximized.	"What happened when you tried out the 'new portable' scenario in your classroom as a way to introduce Mapping A Study Site?" "What would you do differently next time?" "But what will the students do and what are they supposed to learn?" (This stage and the next two stages are impact stages. Participants had to move through the "self" stages where the focus shifted from "me" to the "task." Beginning with Stage 4, the focus shifts to students and others.)
Stage 5 Collaboration	Concerns focus on relating to others what the Follow-Through teams have accomplished. From the outset, VINE Follow-Through had involved teams for the specific purpose of collaborating. So the focus here was not so much on collaborating within individual teams but across teams. Additionally, teams focused on interesting others not involved in VINE Follow-Through in similar professional development experiences.	"VINE Follow-Through is about developing teams for the purpose of creating learning experiences for both students and teachers. I get it now!" "How are we going to share this with others?" (The opportunity to collaborate, reflect on activities, and share experiences with others in a "high risk" context such as a science conference encouraged professional growth in leadership.)
Stage 6 Refocusing	Focus is on finding even better ways to implement VINE Follow-Through, clarifying goals, identifying additional ways to implement new directions, and transferring what has been learned in VINE Follow-Through to new contexts.	"Our team will go on forever; we continue to create both social and professional reasons for meeting." "I no longer want to be a consultant. I found I really like to be a collaborator."

Summary

While VINE Follow-Through was initially conceived to fill a need regarding curriculum, it filled another, unrecognized need as well — the need for teachers, administrators, nonformal educators, university faculty, and others to break through territorial and isolating situations and come to a place of increased respect.

In this process, we all learned the following:

- **Sharing both power and responsibility is an essential element in the development of leaders.** For those used to taking the leadership role, it required patience and trust in group dynamics that the task would, in fact, get done; this was a type of professional growth for them. Classroom teachers' confidence in working with adults increased. Usually the receivers of professional development, many teachers felt that the process of planning and providing professional development experiences for others encouraged them to move to another level of professional growth. As one participant, used to being on the receiving end put it, "For me, VINE Follow-Through was as much about giving as getting!"

- **It takes a long time to move through the Stages of Concern,** but once people get going, get out of the way! Generally, short-term workshop-type efforts stop at the "Management" or "Consequence" stage (Stage 3 or 4) as teachers work to implement curriculum in their classrooms. In effect, they've done what they were "trained" to do. However, in VINE Follow-Through, the knowledge that there would be opportunities to share what they knew with others provided the impetus for everyone to move into the "Collaboration" and "Refocusing" stages (Stages 5 and 6).

- **Working as a team and getting to the goal is messy.** The "tornado effect" describes well the many forces, both internal and external, that buffeted the teams as they forged ahead to meet their goals. Internal tensions developed and were resolved as people came to a common goal and learned to work together more effectively to achieve it. External forces swirled around the teams, constantly dissipating energy and distracting attention. Through all this, individuals persevered, built self-confidence, and became more adept at taking charge of their own destinies as well as contributing to the team's.

Epilogue

In 1993, after an exploratory meeting and several phone calls, Karen Hollweg (NAAEE), Anita Lagerberg (Seattle's VINE Coordinator), Carole Kubota (University of Washington), and Bob Wright (Seattle Public Schools) agreed to apply for grant funding to launch an experiment aimed at addressing a real challenge we faced. We thought that by applying the expertise and resources of a team of educators from formal and nonformal education institutions, we could change what we do collectively and individually and make it possible for classroom teachers to build VINE schoolyard learning experiences into the ongoing classroom curriculum in a way that enables students to *do* more science and construct meaning from their experiences.

As you have read, from 1994–97, teams in three cities formed, worked together to design VINE Follow-Through learning experiences for students that were aligned with their district's and state's learning expectations and frameworks, created a safe environment in which classroom teachers could take risks and try out new things, and promoted and supported changes in teaching and learning. In short, we showed that we could do what we set out to do. In fact, the similarity in results among our three teams suggests that this approach may be generalizable to many situations in which teams could be used to solve problems.

In the final section of this publication, we go a step further and address questions asked by people interested in applying what we've learned to their situations. Here are our responses to three frequently asked questions:

- What would you do differently next time?
- How and where would you recommend applying this approach?
- What is still happening in the three cities you worked with now that the project is done?

WHAT WE WILL DO DIFFERENTLY NEXT TIME

As with any experiment, we learned from this one. Our objective here is to pass on the insights we gained about some things we will do differently next time. Next time we will:

1. **Set forth expectations more clearly and contrast them with participants' more familiar past experiences.** As we have noted in this publication, we found it necessary to reiterate in different contexts throughout the project basic information about our goals, timeline, and expectations for participants. Each time people heard or read this information, they understood it differently, because their understanding of what we meant by "team-based," "problem-centered," "constructivist," etc. had changed and grown.

   As project leaders, we have also gained a clearer understanding of what we mean and expect. We know that by using many of the tools and techniques included in this publication as a starting place, we will be able to set forth our expectations more clearly in the future. In addition, we will also use more activities to **engage participants in comparing, contrasting, and articulating different approaches as a means of clarifying them**. For example, use of the questionnaire on Appendix page E.2 focuses participants' attention on the kinds of professional development experiences they want. Following its use, we advocate engaging teammates in discussions to compare their personal preferences and see how those preferences align with the Professional Development Standards (NSES 1996). Another example is something we began putting together near the end of this project: a chart showing four different foci of learning and, for each, the responsibilities (and appropriate strategies) for teachers and learners. This chart (on Appendix page I.1) could be presented to participants during the Summer Institute as a tool for analysis after their constructivist learning experience, and/or used as a work-in-progress to be revised and refined by the group (as a rubric to clearly define the ways in which teaching and learning behaviors differ depending on the desired outcome).

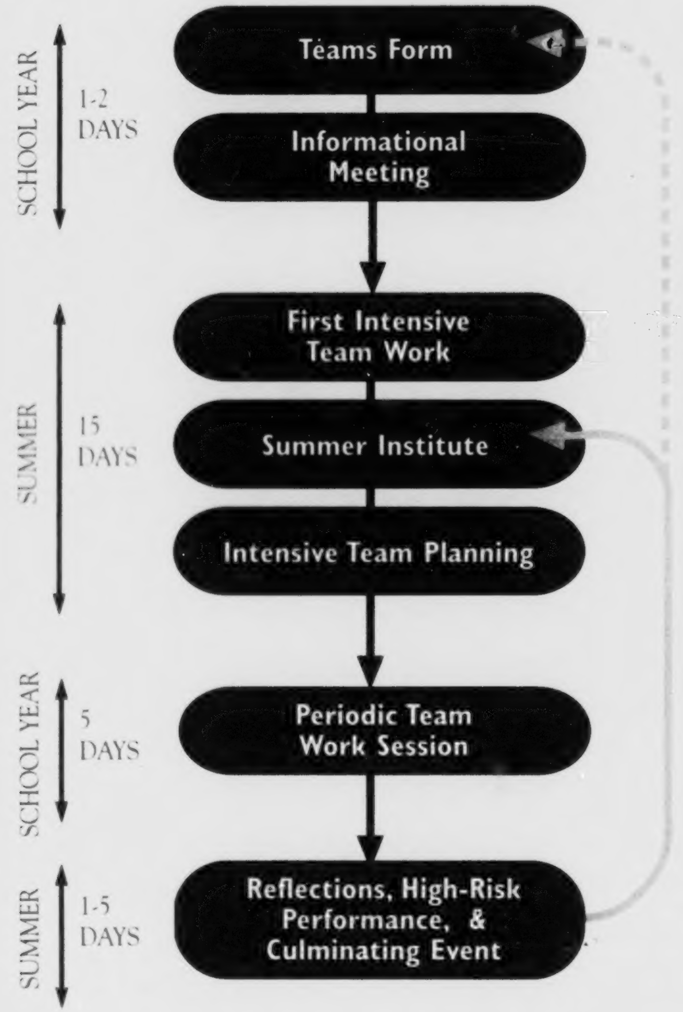
2. **Provide more opportunities during the Summer Institute for participants to pause and reflect on what they were experiencing.** By overtly analyzing what was done and thinking about its effect on learning, we believe that the teaching and learning strategies we were using would have been further illuminated. The reflection could take many forms. As *Facilitating Systemic Change in Science and Mathematics* (Regional Laboratory, 1995) points out, some features of effective learning experiences include processing information by writing in journals, holding small group discussions, discussing questions thoroughly, and comparing notes with others.

3. **Spend more time modeling and discussing how to deal with learners' misconceptions.** By focusing on ways to present learners with alternative explanations, getting them to question their assumptions, and using other appropriate interventions, we believe we can improve both participants' understanding and their use of constructivism. Specific suggestions:

- Use John Zahorik's article, "Encouraging – and Challenging – Students' Understandings" (*Educational Leadership*, 1997), which we have included in our reading list and reprinted in Appendix H.
- Set up expectations from the beginning that different people bring different expertise that the team can tap. A list showing areas of expertise team members are willing to share would have enabled all of us to know from the outset, for example, that Kristi had just finished a year's action research study and could teach us much about the use of classroom meetings for student problem-solving and that Joyce, through her work with marine scientists and government agency employees, knew research ecologists who might help her team and/or their students learn more research skills.
- Emphasize the importance of discussing and resolving differences of opinion. By stressing early on the difference between disagreeing with ideas and not people, we might have enabled some disagreements to surface and get resolved sooner. Through the development of egalitarian teams, we fostered such exchanges, but by adding more emphasis to the importance of voicing diverse views and the reasons for those views as a way to foster learning/conceptual development, we believe we could have promoted more of these exchanges earlier.
- Call in scientists to listen as adults and/or students present the questions they investigated and their findings. Then, the scientists could describe at the end of each presentation ways in which they have used similar techniques and/or additional ways the findings could be interpreted or additional questions that would be interesting to pursue.

4. **Involve participants in designing the project evaluation with the professional, external evaluator(s).** Imposing predetermined project evaluation requirements on participants in a project that is modeling and promoting empowerment and constructivist learning is antithetical. In starting over, rather than meeting as co-principal investigators with the evaluators to discuss and approve an evaluation design, we would have planned a joint presentation to participants to explain the requirements and options for the project's evaluation and would then invite the participants to work with us to determine an evaluation design that met our funders' needs and was workable from participants' perspectives. Besides being more philosophically consistent, we believe this approach would have led to more willing participation.

   In addition, given the current emphasis on and interest in student achievement, we would have measured student outcomes (as well outcomes for the project participants). In 1994, as we began this experiment, both the National Science Foundation and the U.S. Department of Education expected the limited resources for project evaluations to be used on determining how classroom teachers and other participating educators changed, not on measuring gains for students they taught. Times have changed.



5. **Expect teams to work together for two full years.** As shown at the left, the diagram that we used to show the steps through which teams progressed can easily be adapted to depict this idea by adding an arrow. (If new team members are added, the arrow would need to go to the top.) In a second Summer Institute, participants could analyze the progress their students had made in developing targeted understandings and/or skills, learn more about the concept or skills from scientists, and revamp their instructional approach to reflect new insights in the science and/or pedagogy. Alternatively, the Institute could focus on the use of embedded assessment to guide teaching and learning or some other topic that the teams felt they needed to understand more fully and use in their work with students. All three teams found that it took much of the first year to develop into a highly functioning team and saw many options they could productively pursue next. By suggesting a second full year for teams to continue their work around a new goal, either with or without additional members, we feel the time invested in team building would be put to better use.

6. **Expect losses and design entry points/mechanisms for incorporating new blood.** By the time our three teams had worked together sixteen months, they had each experienced the loss of one or more members due to a change of residence, retirement, illness, sabbatical leave, reorganization, and/or downsizing. In this day and age, change in our personal and professional lives is as predictable as change in technology. Therefore, it is important to build into the effort ways not only to bring in new members, but also to carefully integrate them into the team. As the Seattle Team showed, a team with new members needs to jointly formulate a new goal, so that it is truly a *team* goal that all members hold in common.

APPLYING THIS APPROACH TO OTHER SITUATIONS

When we started this project, we hoped that what we did would be applicable not only to VINE Programs, but also to the more than one thousand nonformal science education institutions across the United States that provide programs for teachers and schools (Inverness Research, 1996). The wisdom of educators associated with a range of nonformal institutions was built in throughout this project because our Advisory Committee included educational leaders from the Association of Science-Technology Centers, a large museum, 4-H Extension Service, and government agencies that sponsor programs for schools.

The advisors and many of the project's participants and manuscript reviewers said they believed **this approach can be adapted and used to build into the ongoing curriculum community-based programs other than VINE that provide rich, real-world learning experiences**. And, as we said in the first part of this book, we believe that too, because of the similarity in outcomes of the three teams.

In addition, university faculty members have told us they look forward to using our work in their courses on systemic change and school improvement. We also think this approach can be used in addressing authentic challenges that concern a diverse group of educators – for example, how teachers responsible for pull-out programs can team more effectively with students' regular classroom teachers, or how a school's faculty and staff can work together with corporate education outreach managers for school improvement. We encourage you and your colleagues to do additional experiments to test its applicability.

But keep in mind, it is not enough just to have a challenge and people who might work on it together. We've identified several additional factors that must be considered.

First, there **must be a champion** and, if several different organizations or institutions are involved, there must be a champion within each one. In VINE Follow-Through, the initial champions for the project, who worked on the NSF grant and launched the Seattle Design Team, were Karen Hollweg, Anita Lagerberg, Carole Kubota, and Bob Wright. In addition, the champions that started each of the teams were the coordinators of the VINE Programs. Champions must have the respect of and contacts (or know how to reach contacts) with those who will be involved in order to begin building the team and generating interest. As one of the Seattle teachers said, "I didn't quite understand what VINE Follow-Through was going to be about but when Anita [Seattle's VINE coordinator] asked me to be involved, I said 'yes' just because it was Anita." While VINE Follow-Through involved many different organizations, the process of recruiting people to join a team to work on a joint problem would be similar even within one organization.

Meeting the challenge of VINE Follow-Through required **diverse team members** who brought a variety of perspectives and crucial resources with them. Both diversity of perspectives and access to resources were essential to us. Perhaps the more complex the problem or challenge, the more diverse the perspectives and resources that are needed. For any situation, one of the initial tasks should be to identify what kinds of perspectives and resources will be needed and then to identify the people who can provide them.

External motivators/incentives must be present. VINE Follow-Through had external incentives provided by either the National Science Foundation grant, Eisenhower monies, or other funding to:

- provide stipends for intensive summer work,
- buy substitute time for the teachers during the academic year,
- buy time for others (e.g., VINE coordinators, university and district staff, project director, and co-principal investigator),
- allow for travel,
- buy resources, like books, and simple amenities, like food.

Without external motivators, the work involved in a team effort to solve a problem/challenge, becomes another "add-on." Perhaps one of the reasons why so many efforts to "improve teaching" are resisted is that there is no time for the "add-on." Perhaps the greatest gift that can be provided is time, and that usually takes money. We believe that all professionals on the team need to be compensated for the time they spend on this important work. If the dollars are not available, then some other creative way to provide time will probably need to be found.

Internal motivators/incentives must be present. Individuals in VINE Follow-Through participated in the project for various reasons but, essentially, each one either consciously or unconsciously asked the question, "What's in it for me?" The answer probably took many forms: my students will learn more; my program will play a more important role in the curriculum; part of my salary will be paid. What is offered must "hook" people, be exciting or enjoyable, and be unfamiliar or otherwise challenging. Individuals also had to be "ready." That is, while participants may not have known the particulars of what would happen, they had been invited to work in a team to develop strategies to improve student learning and they had to be at a place in their careers where that was important to them. They had to be "ready" to take risks, to share, and to experiment.

No matter what challenge you choose to address with a team-based approach, we advise you to make sure that **all aspects** of your work are **philosophically consistent**. The professional development experiences of the adults should mirror the types of teaching/learning desired in classrooms.

One of the reasons VINE Follow-Through was successful was that we made a strong case that VINE Follow-Through would **improve student learning** and be aligned with district standards. Outcomes should be clearly stated in terms of increased student achievement and improved student performance aligned with national and district standards. And, those outcomes should be well documented so you can show your funders that their investment was worthwhile.

WHAT HAS CHANGED AND IS HAPPENING NOW

With 2 1/2 years of time, effort, and money invested in the VINE Follow-Through experiment, it would be wonderful to be able to say that it had been disseminated to every school in all three participating school districts. This we cannot claim. Change is slow. We didn't expect institutionalization during the life of this project. We recognize that mass change, influencing all the teachers in the building or institutionalizing a program throughout a city, is slower than slow; it is glacial.

Neither can we claim that the profound effect that VINE Follow-Through had on most of the participants was experienced by every single person involved. We have asked ourselves why VINE Follow-Through had a more profound effect on some participants than others. We can only speculate that perhaps these unaffected few did not have a compelling answer to the question, "What's in it for me?" In those cases, without a compelling answer, VINE Follow-Through became an "add-on" and fell lower on the priority list.

Another conjecture is that perhaps the process and the teamwork involved was too foreign, just not their style, or involved too much time. Or perhaps we are asking too much of ourselves to hope that deep change occurred for everyone.

We can say with confidence that **most of the partipants, teachers and non-teachers alike, changed what they do and how they work**. We can say also that VINE Follow-Through has had a broader impact beyond participants and the students of participating classroom teachers. What has happened since the project ended in 1997?

What's Happening with Classroom Teachers and School Districts?

Once the VINE Follow-Through Project terminated, did participating classroom teachers revert to old ways of doing things with their students? No. The tables and chairs (that replaced the rows of desks) still fill Susan's classroom, enabling her students to work in small groups more readily. **Interdisciplinary, student-centered learning that is more constructivist in nature is still practiced in most of our teachers' classrooms** — and most teachers continue to strive to do more. If we had the resources to collect another round of teacher logs a year or more after the project's completion, we are confident our external evaluator would continue to find more progressive classroom practices being implemented in participating teachers' classrooms as compared to other classrooms. As one team's district representative said, "Teachers changed and changed permanently. They're doing things differently."

In addition, **their "way of work" continues to be more collegial**. For example, teachers in Seattle now speak about expanding Seattle's VINE program in their schools by reaching out to share their Resource Books and enthusiasm for the program with fellow teachers. "For the first time in six years, all the teachers at my school are participating!" was another teacher's proud comment. Some teachers actively seek out opportunities to meet and work with their colleagues; for example, one is leading a group of staff members dealing with enrichment programs at his school, and another is partnering with the science lab teacher to connect more closely what's happening in the science lab with what's happening in classrooms throughout her building.

Other teachers feel much **more confident about speaking out and taking on leadership roles**. The Kentucky teachers have given presentations at the Science Alliance meeting of their district's elementary resource teachers for the second year in a row to encourage others to start similar efforts in their schools. Some teachers are finding it's difficult to change the way professional development funds are spent. One good example is the suggestion made by a VINE Follow-Through teacher to her principal that "student learning improvement grant days (one day a quarter in which teachers work without students) be used to let teachers gather in grade level groups to share what is working in their classrooms." This suggestion was "taken under advisement" and never implemented; instead, an "assessment expert" was hired for the day to "train" staff on new assessment techniques. Another teacher in a different district was able to get her principal to allocate building-level monies to fund regular after-school meetings of her fourth-fifth grade team, use her VINE Follow-Through experience as a model, and facilitate a team-based effort to integrate outdoor, hands-on experiences into all fourth- and fifth-grade classrooms at her school. But turnover in principals make continued support for such initiatives tentative.

One school district team member said this project reaffirmed his attitude that **professional development needs to be changed**. He said, "We have to be able to release teachers from their daily classroom duties if we're really going to make a change in what they do. Teachers can indeed create and implement their own professional development if given the right leadership and latitude."

Some heartening efforts, occurring at the district level, will, we hope, portend additional changes. Elementary science resource teachers in Florida and in Kentucky are being given time to meet together and network. And in the Seattle schools, while VINE Follow-Through has not been institutionalized, the local VINE Program has been officially recognized and inserted in the district curriculum as *the* environmental education component for fourth grade. VINE Follow-Through was instrumental in drawing attention to the local VINE Program and bringing the district to at least the "awareness" level. Ideal next steps would be to ensure that all fourth graders not only experience VINE, but also that all fourth-grade teachers build the VINE experiences into their ongoing curriculum and that districts provide time for all teachers to meet and work with colleagues. There are still no assurances that will happen.

What's Happening with Nonformal and Post-secondary Education Participants?

As with those in schools, the VINE Follow-Through participants from nonformal and post-secondary education have changed what they do as they try to **incorporate more constructivist and collaborative work back in their own settings**. A university science educator, for example, now collaborates with scientists in her course that prepares elementary teachers to teach science. She has influenced her university colleagues to collaborate with mathematicians in the "math methods" course and with authors in the "literacy methods" course for teachers. The post-secondary and nonformal educators from another team jointly attended a meeting sponsored by their state Department of Education's Office of Environmental Education this year, and found that their VINE Follow-Through experience had given them much deeper understandings of constructivism and teamwork than the others at the meeting had. Those experiences and understandings were deemed valuable to everyone. As a result, the two have been involved in the revision of a set of state curriculum materials and have planned and facilitated a series of workshops on constructivism for Regional Service Office training facilitators.

The local VINE coordinators in the VINE Network (whose discussions initiated the idea for this VINE Follow-Through experiment) continue to meet annually at NAAEE conferences. Their deliberations are still filled with the kinds of pragmatic sharing of successes and discussions of solutions for problems that have supported their ongoing efforts to improve and sustain their programs. This year, Baltimore's VINE coordinator is working to start a VINE Follow-Through team and Summer Institute in his city.

We think that the fact that the co-principal investigators for this project represent the nonformal and higher education sectors is significant. As one colleague pointed out, it may be easier to initiate change from outside. What we know is that we were able to use grant monies, from the National Science Foundation in this case, to leverage the allocation of school districts' Eisenhower Funds for this experiment. And we feel **more partnerships are needed** to change existing professional development and classroom practices in schools and to enable professionals to interact with one another over time on problem-centered challenges. Through such partnerships, **we can all continue the process of changing what we do and improving the learning experiences we provide youngsters.**

A WORD OF ENCOURAGEMENT

VINE Follow-Through involved multi-faceted teams from disparate institutions and, with the involvement of three different cities, was a tremendous logistical challenge. We don't think most change efforts have to be as complicated. Additionally, the project director and co-principal investigator had met only once before embarking on this project together and were located three thousand miles apart. Chances are, your efforts will be more localized so you can meet together face to face as you plan. You may know many of the people you want to involve and may even have worked with them as colleagues on previous projects.

In VINE Follow-Through, we worked with many participants: the Design Team, two additional leadership teams, and an "expansion group" of ten Seattle teachers. That's a lot of people. Most likely, you will be starting small with one team. Don't worry about expanding for at least a year. If and when you do expand, expand slowly. Perhaps you do not even need to expand if the challenge/problem that your team is addressing has been resolved by the team. Then your team will disband and you will move on to the next challenge. (There will always be another one!)

We've tried to describe the project's outcomes in terms of the professional development of teachers and others. We've related stories of how we all changed and the resulting changes in teachers' classes. But equally as important, we have described our process. It is this process that you may find most useful. Take time, trust in the process, and trust in the team. We feel good that we did and are confident that you will too.

People change by doing new things
in conjunction with others.

Fullan and Stiegelbauer, 1991

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Appendices

A. Project Description – a basic one page summary of the project objectives and timeline A.1

B. Worksheets for Getting Started – to help you and your colleagues think through important design elements
- How Can We Amass Enough Resources to Support a Team? B.1
- Creating an Interlocking Programmatic Fit B.3

C. Responsibilities and Benefits for Teams – an itemized list used to recruit new teams in the second year of the project C.1

D. Project Application Forms – used for assessing readiness and commitment to the project
- Team Application Form D.1
- Timeline and Budget D.2
- Application Form for Team Members from the District's Curriculum and Instruction Office, University, and Nonformal Education Institution D.3
- Teacher's Application Form D.4

E. Materials for Informational Meeting – items for use at each site's first meeting to inform prospective team members about project plans and expectations
- Purpose, Process, Products E.1
- Which Kinds of Professional Development Experiences Do You Want? E.2
- National Science Education Standards for Professional Development E.3

F. Materials for Beginning Intensive Work of Teams – a combination of information plus structured and open-ended activities that guided teams in preparing for the Summer Institute (Also see pages 48-53.)
- Objectives for First Week, Prior to Summer Institute F.1
- Some Effective Team Building Strategies F.2
- The Cube F.4
- Reflecting on Practice F.6
- Suggestions for Individual Interviews Regarding Ecological Concepts F.11

G. Summer Institute Team Building Activities – information and activities used with participants
- What Crucial Roles Must Be Filled? G.1
- Work Styles Profile G.2
- Airplane G.8

H. Summer Institute Reading List and reprints of items referred to in the narrative
- Reading List H.1
- Teaching for Conceptual Change: Confronting Children's Experience H.2
- Encouraging – and Challenging – Students' Understandings H.8
- Strategic Teaching in Science H.11
- What Instructional Methods Support Scientific Thinking and Problem Solving? H.27

I. Learning Focuses With Different Teacher and Student Responsibilities – a work-in-progress that we put together near the end of the project (We suggest possible uses for this chart on page 104.) I.1

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Project Title and Description

VINE Follow-Through: Developing Strategies and Materials for Promoting More Meaningful Classroom Follow-up to Informal Science Hands-on Investigations.

Project Summary

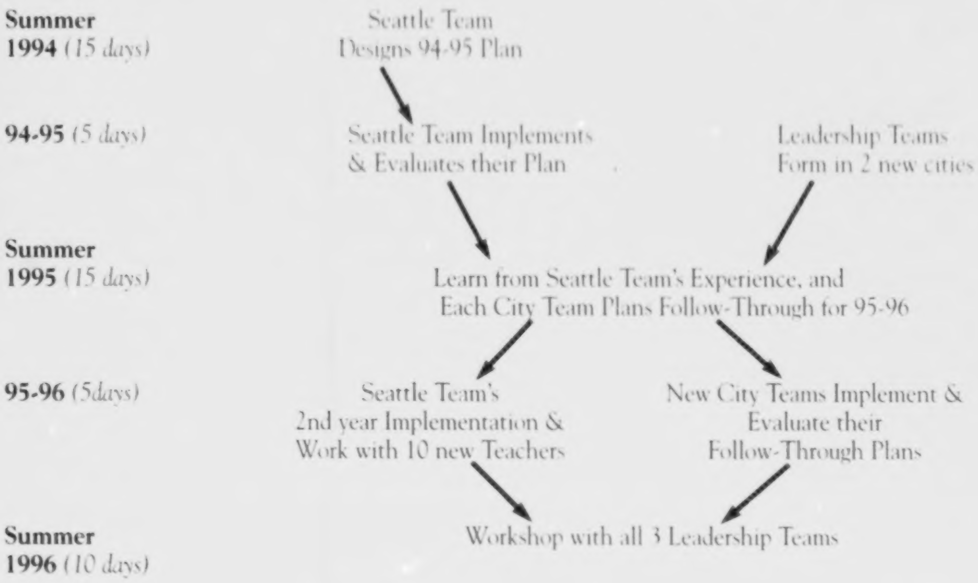
VINE Programs provide 4th graders, and in some cases 3rd and 5th graders, across the U.S. with opportunities to investigate the plants, animals and ecological interactions occurring on their schoolgrounds. **VINE Follow-Through** builds on these experiences and on current research regarding teaching, learning and educational change. From 1994 through 1997, the project will:

1. Work with Leadership Teams in three cities to design and test a set of strategies for developing collaborative teams and leading professional development initiatives. The strategies will be designed to enable teachers to follow up on VINE investigations in a manner that will enable students to do more science and construct meaning from their experience.
2. Document those strategies and produce professional development materials which can be used to apply this model in additional settings.
3. Evaluate this model for building on informal science education experiences and promoting science education reform and assess its potential for use in conjunction with informal science education experiences offered through science museums and other community-based institutions.

Each city's team will include 5 experienced teachers, a district curriculum coordinator, a university science educator, and a VINE project coordinator. The Advisory Committee's impact throughout the formative stage will guide us in creating a product that has broad potential and can be used by the science museums and other informal science education agencies that work with schools in virtually every city.

Funded by National Science Foundation's Elementary, Secondary & Informal Education Section with matching funds from Eisenhower Funds and other local sources.

What's the timeline?


Summer 1994 (*15 days*)
Seattle Team Designs 94-95 Plan
94-95 (*5 days*)
Seattle Team Implements & Evaluates their Plan
Leadership Teams Form in 2 new cities
Summer 1995 (*15 days*)
Learn from Seattle Team's Experience, and Each City Team Plans Follow-Through for 95-96
95-96 (*5days*)
Seattle Team's 2nd year Implementation & Work with 10 new Teachers
New City Teams Implement & Evaluate their Follow-Through Plans
Summer 1996 (*10 days*)
Workshop with all 3 Leadership Teams

We anticipate that each team will continue to involve more teachers and build on their successes through local professional development activities following the grant period.

How Can We Amass Enough Resources to Support a Team?

Use this matrix for assessing and accessing resources and knowledge which people can bring to your team. The left hand column lists all the skills and abilities valuable for a VINE Follow-Through team. Revise this list, adding your own items, to reflect resources your team will need — e.g., people with special expertise in assessment and evaluation. Then, place the names of prospective team members across the top on the slanted lines and check the items in each column, as appropriate. In the far right column, total the number of ✔'s for each line.

In building your team, strive for **redundancy** — i.e. at least two checks per line. Our experience indicates that your chances for success and ability to ride out the vagaries that come your way will be greater the more ✔'s you have in each line.

										Total ✔'s
➨ Has access to/can acquire **money*** to pay for salary of: University faculty										
School district curriculum specialist										
Nonformal education / community resource person										
Team coordinator										
Teachers' substitutes Saturday/hourly pay Summertime pay										
➨ Thoroughly understands the **nonformal education** or **community resource** being used: Has used program for one or more years										
Can influence content and/or affect delivery										
➨ Knows **district's elementary science curriculum and materials**: Has used curriculum and materials in an inservice setting										
Has used curriculum and materials in a classroom setting										
Knows how to use and affect changes in district's support of/for these (e.g. materials, inservice training, technology/computer access, buses or other support needed)										

(Continued on page B.2)

➡ Proficient in using relevant **classroom teaching techniques**: Cooperative learning with small groups										
Open-ended questioning										
Student-centered discussions and decision-making										
Alternative/authentic assessment										
Interdisciplinary units linking disciplines of _______________										
➡ Has planned and delivered **professional growth programs:** Can acquire credit (university and/or inservice credit)										
Knows and practices most effective educational change strategies and what's known from teaching/learning research										
Has experience working in teams of professionals										
➡ Understands thoroughly and has experience implementing national, state and district-level **standards, mandates, frameworks, priorities,** esp. regarding:										
Concepts and processes students are expected to understand/develop										
Teaching strategies/practices										
Assessment practices and policies										
Program quality and conditions										
Support and resources needed for implementation										
Ability to obtain district-level sign-off/approval,support,resources										
➡ **Has strong science content knowledge:**										
Understanding of concepts addressed in the program										
Working knowledge of current research and state of understanding regarding the concept (s)										

* "money" for salary may come from a private foundation or government-funded grants, or a principal's allocation of days for teachers' professional growth, a district's Eisenhower funds, a corporate sponsor, or a boss' discretionary funds or ability to shift workload assignment(s).

Programmatic Fit

Does your program interlock with other priorities for a strong, well-supported fit?

District Standards and/or State Mandates

- What priorities or expected changes can be addressed by building on nonformal/community educational experiences?

Professional Growth

- Does this exemplify the priorities to which professional growth monies are being allocated?
- Is the intended audience interested?
- Are professional development providers enthusiastically "on board"?

Curriculum Content

- What concept(s)/ skill(s) that are part of the approved curriculum will the nonformal/community educational experience(s) introduce/develop?

Special Learning Experiences

that model elements of education reform (e.g., inquiry, cross-age or intergenerational experiences, small groups, community involvement) and are provided to schools by **Nonformal Institutions/ Community Resources**

1995-96 VINE Follow-Through Project
Responsibilities & Benefits for Leadership Teams from 2 New Cities/Counties

Team's Responsibilities

- prepare for the '95 Summer Institute by providing the Seattle Design Team with baseline information and materials, and by identifying the schoolyard investigations and district curriculum goals/standards which your team's plans will address.
- fully participate in the July 9-16, 1995, Summer Institute in Seattle to learn from the Seattle Team's experiences regarding constructivist teaching/learning, classroom management strategies for facilitating open inquiry, and the assessment of student understandings and skills.
- collaboratively design and carry out strategies to enable your area's students to build on their schoolyard investigations in ways that will actively engage them in wondering, asking questions, finding answers, developing inquiry skills, creating explanations and constructing ecological concepts.
- use reflection and a variety of assessment strategies to assess initial understandings, document growth, and determine outcomes of your team's efforts.
- work with Teams from other cities to compare findings and help others learn from our collective experiences (especially during the summer of 1996).
- develop a forward-looking plan to further expand the efforts of your team.

Responsibilities of Team Facilitator

- serve as primary contact with national VINE Follow-Through Project Director.
- facilitate/"chair" the team's deliberations, making sure that logistics, organization, and identified tasks are attended to, that plans are made, revised (as necessary) and achieved.
- promote a sense of mutual ownership, collegiality, and shared leadership among team members. Ensure that the expertise, experiences and ideas of all team members contribute to the team's efforts and products.
- ensure the dissemination of information/expectations from the Project Director and from other teams to all team members.

Benefits of Participation

- opportunities to work on a national project with colleagues who share your interests
  - learn from the Seattle Design Team and their 1994-95 experiences in initiating the Follow-Through Project,
  - tap the individual and collective wisdom of the Follow-Through Advisory Committee, and gain insights and advice from the project's outside evaluators.
- NSF Funding of $41,610 over 15 months, as detailed in application materials.
- development of a local project that will provide a focus for
  - building a multi-institutional professional growth team,
  - developing strategies for constructivist learning and teaching,
  - creating an elementary school program that models reform-minded practices and teacher leaders who can help spread these practices.
- opportunities for personal/professional growth and leadership development.

If our hypothesis proves true, what we create here will provide insights that can be used to design constructivist inservice courses and classroom follow-through for other hands-on experiences provided to your schools' elementary students by other informal institutions through field trips and/or in-school sessions.

Criteria for Selection of Leadership Teams for 1995-96 participation will be based on

- strength and growth of the on-going local VINE program.
- evidence of commitment to this project by team members and their institutions.
- the project's fit with on-going or planned larger efforts, including support for city-wide or county-wide science and/or environmental education reform.
- the background and experience of team members.

1995-96 VINE Follow-Through Project Team Application Form

______________________________________'s Leadership Team consists of 9 members as listed on the
(City or County)

the attached roster. ______________________________ will be the Facilitator of our Team.

1994-95 School Year Program Data for ____.
(local VINE Program title)

This year our VINE program will be in ______ elementary schools and ______ classrooms.
List total number of participating teachers by grade level:
______ 5th grade teachers ______ 4th grade teachers ______ 3rd grade teachers

By 1995-96, we expect our program to be in ______ schools and ______ classrooms.

Demographics of students (If the same schools are involved as in 1993-94, check here ☐.)

_______% American Indian or Alaskan Native	_______% White, not Hispanic Origin
_______% Asian or Pacific Islander	_______% Other
_______% Hispanic	_______% living at or below poverty level (receiving totally free school lunch)
_______% Black, not Hispanic Origin	

Evidence of Need - Describe the observations made and/or data collected that show a need to develop a Follow-Through Program in your city.

Contribution to Educational Reform - Describe how your local VINE Program and this Follow-Through initiative fit with your institutions' efforts to reform science/environmental education at the elementary level.

Attach a budget showing your team's local funds and in-kind salaried days.

1995-96 VINE Follow-Through Project Timeline and Budget

	What's Involved	Time	NSF Funding for each Team
1994-95	Identify a Leadership Team of 9 people: local project coordinator, 5 experienced teachers, school district curriculum coordinator, university science education expert and one other, as needed	Meetings & Phone calls	
	Application deadline and selection	Jan 10 & Feb 1 '95	
	Meeting of potential team members in their city to learn what's involved ask/answer questions (with Karen)	1.5 hours	$ for Refreshments
	Possible video/audio communication and correspondence with Seattle Team (in preparation for summer)		
Summer 95	Institute & Workshops/Meetings for new Leadership Teams, includes: – preparation for Institute at home, May-June, 3 days – institute in Seattle, July 9-16 – planning for 1995-96 school year, July-Aug, 5 days	15 days	Stipends $8100 Travel $7200* Rm/Bd $6300*
1995-96	Implement VINE Follow-Through Plans – Team meetings throughout school year to assess progress, build team, do additional planning and make mid-course corrections, and finally to summarize results	5 days	Stipends $3000
Summer 96	Workshop with all 3 City Leadership Teams to pool results, learn from each others' experiences, and review action research and outside evaluators' report. Design local inservices and follow-up support systems for continuing the change process. Review, critique, and finalize staff development materials for use in inservices. Prepare proposals for further dissemination.	10 days	Stipends $5400 Travel $7200* Rm/Bd $4410*

NOTE: Each city is expected to allocate some Eisenhower or other staff development funds and/or in-kind salaried days (e.g. for university or school district personnel) to this project. (Seattle Public Schools' contribution for 1994-95 was approximately $13,000). Attach a budget showing how your team will acquire enough resources to supplement NSF funding and support the participation of all team members.

* These funds will be budgeted to cover expenses of Team's July travel to and stay in Seattle as well as travel expenses for follow-up consultation by/with Seattle Team members.

1995-96 VINE Follow-Through Project

Application Form for Team Members from the District's Curriculum & Instruction Office, University, & Nonformal Education Institution(s)

Individual Information for ______________________________
(name)

a member of the 1995-96 VINE Follow-Through Team from ______________________________
(city or county)

I. I understand that by applying to participate in this project, I am committing to work with the other members of our Team to meet our responsibilities.

Team's Responsibilities

- prepare for the '95 Summer Institute by providing the Seattle Design Team with baseline information and materials, and by identifying the schoolyard investigations and district curriculum goals/standards which your team's plans will address.
- fully participate in the July 9-16, 1995, Summer Institute in Seattle to learn from the Seattle Team's experiences regarding constructivist teaching/learning, classroom management strategies for facilitating open inquiry, and the assessment of student understandings and skills.
- collaboratively design and carry out strategies to enable your area's students to build on their schoolyard investigations in ways that will actively engage them in wondering, asking questions, finding answers, developing inquiry skills, creating explanations and constructing ecological concepts.
- use reflection and a variety of assessment strategies to assess initial understandings, document growth, and determine outcomes of your team's efforts.
- work with Teams from other cities to compare findings and help others learn from our collective experiences (especially during the summer of 1996).
- develop a forward-looking plan to further expand the efforts of your team.

I will actively participate in the workshops and meetings our team schedules and in the 1995 and 1996 Summer Institutes that are part of this project.

signed ______________________________

date ______________________________

II. Given your understanding of the project, your team, and your personal and professional strengths, what do you anticipate your role in the team will be as all of you work together?

1995-96 VINE Follow-Through Project Teacher's Application Form

Name: ______________________________

School Address: ______________________________

Home Address: ______________________________

Phone: ______________________________

Phone: ______________________________

Current teaching assignment/grade level: ______________

Years, elementary school teaching experience: ______________

Check each of the items listed below that describes a classroom management or teaching technique that you use regularly with your students:

- ☐ small group work
- ☐ hands-on science
- ☐ thematic teaching
- ☐ team teaching
- ☐ cooperative learning
- ☐ math manipulatives
- ☐ student centered discussions
- ☐ open-ended questioning
- ☐ alterative or authentic assessment

How often do you teach science? __________ hours/week __________ times/week

Would your colleagues describe you as a "science advocate?" ______________

How long have you been involved in your city's volunteer-led schoolyard ecology program?

Describe the best professional growth experience which you've had in your teaching career and describe what made it so good.

List participation in professional conferences and courses since January 1990.

On the back of this sheet, briefly describe your best science lesson. Why is it "best"? What do your students learn from this lesson? Include a description or list of materials you use such as books, worksheets, videos, manipulatives, equipment.

In what ways would you like to see science teaching improved in Grades 3-5?

Describe any changes you've made in your classroom/curriculum in order to integrate the volunteer-led schoolyard investigations into your on-going program.

Describe any personal strengths or abilities which would seem especially appropriate to this project, as described.

By signing and submitting this application to the VINE Follow-Through program you are acknowledging that you will participate in the following activities:

- Summer 1995 - 15 days working with your city's Leadership Team, includes July 9-16 Summer Institute in Seattle,
- 95-96 School Year - implement and evaluate classroom activities and participate in 5 Saturday and/or substitute release-day team meetings, and
- Summer 96 - 10-day workshop in Seattle plus possible inservice activity in 1996-97.

Note: Stipends will be paid for work done at times that are not covered by regular teaching contracts. Substitutes will be provided when absence from your classroom is required.

Teacher's Signature ______________________ date ______________

I have reviewed this application, and recommend this teacher for our city's Follow-Through Team. If s/he is selected, I will support him/her in participating in this project.

Principal's Signature ______________________ date ______________

NAAEE
NORTH AMERICAN
ASSOCIATION FOR
ENVIRONMENTAL
EDUCATION

VINE Follow-Through

Purpose: To integrate local VINE programs into the on-going curriculum by creating learning opportunities for kids that meet state and school district frameworks and learner outcomes, promote higher-level thinking about the plants, animals, habitats and ecological interactions on their schoolyards, and enable students to do more science.

Process: Learn from the 1994-95 experiences of the Seattle Design Team. Work with your team to design, try out and revise products that you think will work with your students. Share, give and take, question, compare, explain, and seek clarification with teammates as well as other teams and project advisors. Reflect on and evaluate what you do to learn from your successes and mistakes and to decide what to do next.

Products [followed by timeframe]:
Plans for projects and/or sequences of learning experiences to be used with 1995-96 students. [Summer 1995]
Journals, logs, portfolios and other pieces of evidence that can be used to determine how well the plans work. [1995-96 school year]
Generalizations (patterns and principles) about successful student projects and/or learning experiences. (i.e., a synthesis of what we've learned) [summer 1996]
Plans for going further and/or involving more people. [summer 1996]

If you have questions or concerns, please phone, fax or write. We welcome your questions!

VINE Follow-Through Project
NAAEE
1255 23rd Street, NW, Suite 400
Washington, DC 20037-1199
202-884-8912 or 202-884-8894
202-884-8701 FAX
khollweg@aed.org

4/95

Which Kinds of Professional Development Experiences Do You Want?

Circle the ones in which you would most like to participate.

1. one day topical workshops
2. team efforts with university, district, teacher, and community members working as colleagues
3. courses taught by enthusiastic experts
4. focused one to two year projects that will enable me to develop new skills
5. make-and-take it sessions
6. opportunities to honestly examine and compare classroom practices with colleagues
7. chances to think about what I'm doing and could do to improve student learning
8. lectures on the latest learning theories
9. experiences that support me in trying new approaches
10. sessions with activities I can do with my students the next day
11. well-organized classes that enable me to really learn the content I'll be tested on
12. courses that model teaching and assessing concepts in integrated ways
13. programs that meet periodically throughout the year

Each kind of professional development experience described here can be valuable. The kind described in this publication emphasizes characteristics described in numbers 2, 4, 6, 7, 9, 12, 13. Give yourself a point for each of these you circled. People who score 5 to 7 points will most likely find a congruency with their interests and the ideas and approaches of the VINE Follow-Through Project.

Once each team member has individually completed and scored his/her responses, discuss your preferences as a team. For example, what types of professional development experiences do the members of your team value most?...and why? This discussion should enable your team to assess whether the members are in agreement regarding the long-term nature of this endeavor, the role of the team in planning and supporting new approaches to teaching and learning, the opportunities members will have to examine their current practices and develop new skills.

Finally, in pairs, review the "Changing Emphases" sheet from the NSES Standards for Professional Development (on the next page) and decide the degree to which this type of professional development addresses the Standards. For example, which emphases do you and your discussion partner seek. . . and why are these priorities for you at this point in your career? or which emphases listed in the National Science Education Professional Development Standards seem like they will be most directly addressed by our team-based, problem-centered approach?

CHANGING EMPHASES*

The *National Science Education Standards* envision change throughout the system. The professional development standards encompass the following changes in emphases:

LESS EMPHASIS ON	MORE EMPHASIS ON
Transmission of teaching knowledge and skills by lectures	Inquiry into teaching and learning
Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice in school settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as educators	Staff developers as facilitators, consultants, and planners
Teacher as technician	Teacher as intellectual, reflective practitioner
Teacher as consumer of knowledge about teaching	Teacher as producer of knowledge about teaching
Teacher as follower	Teacher as leader
Teacher as an individual based in a classroom	Teacher as a member of a collegial professional community
Teacher as target of change	Teacher as source and facilitator of change

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*National Research Council. **National Science Education Standards**. p. 72. (1996). Washington, D.C.: National Academy Press

Standards for Professional Development*
Which This Project Addresses Most Directly

The current reform effort requires a substantive change in how science is taught; an equally substantive change is needed in professional development practices...If reform is to be accomplished, professional development must include experiences that engage...teachers in active learning that builds their knowledge, understanding, and ability. (p. 56)

- The conventional view of professional development for teachers needs to shift from technical training for specific skills to opportunities for intellectual professional growth.
- The process of transforming schools requires that professional development opportunities be clearly and appropriately connected to teachers' work in the context of the school. (p. 57)

STANDARD A:

Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry. Science learning experiences for teachers must...

- Build on the teacher's current science understanding, ability and attitudes.
- Incorporate ongoing reflection on the process and outcomes of understanding science through inquiry.
- Encourage and support teachers in efforts to collaborate. (p. 59)

STANDARD B:

Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching. Learning experiences for teachers of science must...

- Occur in a variety of places where effective science teaching can be illustrated and modeled, permitting teachers to struggle with real situations and expand their knowledge and skills in appropriate contexts.
- Address teachers' needs as learners and build on their current knowledge of science content, teaching, and learning.
- Use inquiry, reflection, interpretation of research, modeling, and guided practice to build understanding and skill in science teaching. (p. 62)

STANDARD C:

Professional development for teachers of science requires building understanding and ability for lifelong learning. Professional development activities must

- Provide regular, frequent opportunities for individual and collegial examination and reflection on classroom and institutional practice.
- Provide opportunities for teachers to receive feedback about their teaching and to understand, analyze, and apply that feedback to improve their practice.
- Provide opportunities for teachers to learn and use various tools and techniques for self- reflection and collegial reflection... (p. 68)

STANDARD D:

Professional development programs for teachers of science must be coherent and integrated. Quality preservice and inservice programs are characterized by

- Clear, shared goals based on a vision of science learning, teaching, and teacher development congruent with the *National Science Education Standards*.
- Integration and coordination of the program components so that understanding and ability can be built over time, reinforced continuously, and practiced in a variety of situations.
- Options that recognize the developmental nature of teacher professional growth and individual and group interests, as well as the needs of teachers who have varying degrees of experience, professional expertise, and proficiency.
- Collaboration among the people involved in programs, including teachers, teacher educators, scientists, administrators, policy makers, members of organizations, parents...with clear respect for the perspectives and expertise of each...
- Continuous program assessment that captures the perspectives of all those involved, uses a variety of strategies, focuses on the process and effects of the program, and feeds directly into program improvement and evaluation. (p. 70)

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*National Research Council. ***National Science Education Standards***. (1996). Washington, D.C.: National Academy Press.

VINE Follow-Through Project
Objectives for South Florida and Louisville Teams
(to be Achieved Prior to July Summer Institute)

1. **Get to know the people on your team as individuals, and begin building the team's sense of identity and trust.**

   a. Through "get acquainted" and team-building activities, learn about the other members of your team. You might want to have a different member lead the group in a new activity each time you meet.

   b. Visit the school sites of your teams' teachers. The Seattle team took time early-on to visit each other's schools and schoolgrounds This enabled them to gain a "sense of place" for one another, and they recommended that the new teams do something similar.

   c. Together, create a Team Product to introduce yourselves to the Seattle Team.
   [See Team Product sheet for guidelines.]

2. **Collect data and begin to analyze *what is*. (Since we will be drawing on this preliminary work during the Summer Institute, be sure to bring your products/findings with you to Seattle.)**

   a. Describe what you expect to get out of the VINE Follow-Through Summer Institute. By taking some time individually to record expectations in a journal, you'll have a record of everyone's initial views. That could provide a starting point for discussions and work on your Team Product.

   b. List the outdoor investigations that your students do with their volunteer-led groups. Include investigations that have been done in previous years and are still possible.
   (Bring 1 team-reference set of these investigations to Seattle.)

   c. Review your state frameworks and state, school or district-level learner outcomes. Keeping in mind the investigations listed under 2b. and the VINE Follow-Through goals of engaging children in doing more science and constructing meaning from their investigative experiences, decide which outcomes might be best achieved by a Follow-Through approach. Include outcomes involving science content/concepts and processes/"habits of mind" and environmental education. (Your team should bring to Seattle one set of the reference documents you use in doing this.)

   d. You undoubtably know quite a bit about your students' thinking from their products and discussions. Recently, a group of British researchers has used individual interviews as a way of finding out what youngsters of various ages know and understand regarding ecological concepts. While we do not expect you to interview large numbers of children, we do hope you'll try this as a different way of getting to know about the thought processes of 3rd graders — i.e., your "incoming" 1995-96 students. Interviewing 2 or 3 children, who represent a range of abilities, may give you a slightly different picture of the thoughts your kids have about **decomposition** or **ecological interrelationships** or **habitat.** Pick one of the concepts you listed in 2.c.

   Sample interview guidelines, based on the work of the British researchers, are attached for your information. Once you've each had a chance to interview a few kids, talk about it with your team. What did you learn from the kids? What was/were the things(s) that surprised you most?

Note: Additional housekeeping tasks will be expected — such as distribution and processing of forms for housing and arrangements for travel.

What Are Some Effective Team Building Strategies?

While there are entire books written on how to build teams, we found the following activities to be especially helpful. Below are the team building activities* in which our teams engaged. Some activities are most effective if done early. Others are more effective done later as trust deepens between team members. Some activities can be done anytime. Some activities are basic and everyone can participate; others are more complex and require a facilitator with some knowledge about the activity. Whether you use these or your own favorites, remember that the reason you are building your team in the first place, is so that you can more effectively achieve your goal.

Name tags *early, basic*

Purpose: Introductions, icebreaker.

Process: Individuals answer 4 questions on the corners of their nametags. For example: "What is the most unusual or scariest thing you've ever done? What is the best part of your job? What is your favorite place or way to relax? Why are you in education?"

Setting Goals *early, basic*

Purpose: Reach mutual understanding, hold a common vision.

Process: This is ongoing and will need to be continually revisited as situations change, time and other resources come and go, and commitments redefine.

Post your goals — both long and short term goals — at every meeting.

Science Autobiography *early, basic*

Purpose: Icebreaker, find out how experiences have shaped our attitudes and beliefs about science.

Process: Individuals journal for 10 - 15 minutes describing their own personal experiences with science, in or out of school, from the ages of 0 - 10 years, 11 - 18, and 18 and above. Then, based on personal experiences, complete the sentence: Science is. . . Pairs trade their writing with each other and ask clarifying questions. Share memories as a group.

(For details, see *Science and Children*, Nov/Dec 1990, pg. 42-3.)

Team Basket *anytime, basic*

Purpose: Icebreaker, can be used to introduce your team to others.

Process: Individuals bring items representative of themselves to make a "team basket." As items are placed in basket, individuals explain their significance.

Work Site Visits *early, basic*

Purpose: Provide insight into each others' work environments.

Process: Take an afternoon to carpool to each other's work sites, see and learn about both the work setting and the people with whom each of you work.

* *Add* ***your*** *favorite team building activities to this list!*

What Are Some Effective Team Building Strategies? (continued)

Meet in Homes *anytime, basic*

Purpose: Provide insight into each others' lives and interests outside work.

Process: Super simple - just schedule meetings at each others' homes! Potluck lunches or dinners make the meetings a social event as well as a work party.

Team Product *anytime, basic*

Purpose: Celebrate/advertise team's accomplishments.

Process: Produce a video or gather artifacts (photos, minutes, finished products) in one place: a box, an album, a binder. Use the team product/portfolio to recruit others into your efforts and to share what you've done.

Celebrations *anytime, basic*

Purpose: Energizer.

Process: Celebrate everything, small steps as well as risk taking! So you took a risk and it didn't turn out quite the way you thought. Celebrate it anyway - even "failures" should be celebrated as learning opportunities!!

Socializing *anytime, basic*

Purpose: Energizer, provides insight into each other's lives both inside and outside of work.

Process: Start meetings by catching up with people's lives before jumping into the meeting's tasks.

The Cube *early, complex*

Purpose: Emphasizes the importance of teamwork.

Process: See "The Cube", Appendix pages F.4-5.

Airplane *later, complex*

Purpose: Understand the importance of communication.

Process: See "Airplane," Appendix pages G.8-16.

Work Styles Profile *early, complex*

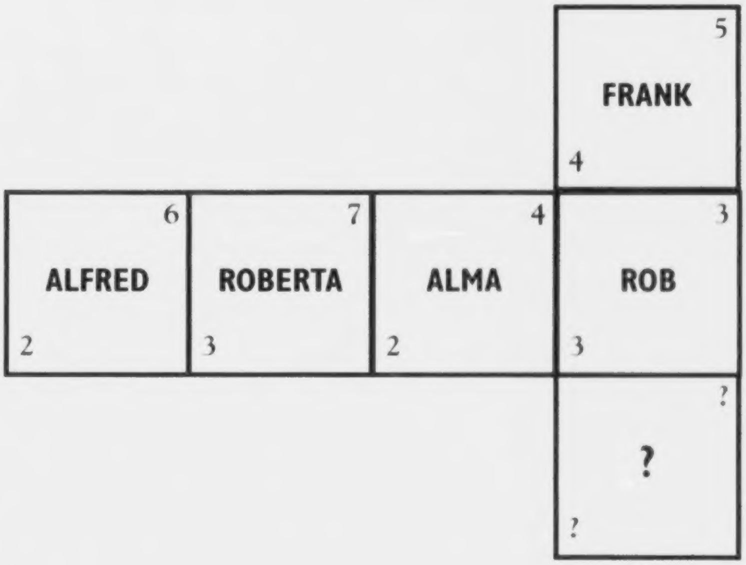
Purpose: Understand personal styles, value diversity

Process: See "Work Styles Profile," Appendix pages G.2-7.

The Cube*

Purpose:	Team building, collaborative problem solving, multiple valid solutions
Time required:	15 minutes to solve the problem 15 - 30 minutes to debrief
Materials:	Cardstock squares (4 inches x 4 inches) taped into Cubes Scotch tape Marking pens Extra card stock squares (4 inches x 4 inches)

Getting Ready:
Write the names and numbers on the squares as shown below. Tape six squares together *exactly* as shown to form each Cube. You should end up with a Cube that has the square with the question marks on the bottom of The Cube and the square with the name "Frank" on the top of The Cube.



Procedure:
Work in teams of 3 - 5 depending on group size. Place a Cube in the center of each team. Explain that the teams have 15 minutes to meet a challenge and that they are NOT ALLOWED to pick up their Cubes. Distribute a square and marking pen to each team. Then give the teams the challenge below:

> Using the information provided on the five sides of The Cube that you can see, design the sixth side.

Each team is to record its design for the sixth side of The Cube on its square.

If the teams need hints on how to get started, ask them to make observations and to find patterns and relationships from the information given on the sides of The Cube that they can see.

---

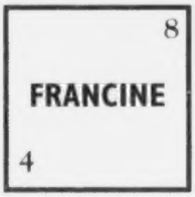
* *Original author unknown.*

After the teams have completed their squares, debrief the activity by asking them to:

- share their squares,
- justify the information they have recorded on it,
- share the process of how they made their decisions, and
- describe any insights about teamwork that they gathered from the activity.

Teams should have gained a good understanding of some of the important aspects of teamwork, e.g. having a common goal, building on one another's ideas, self-correcting with new information, making connections, answering questions leads to more questions, listening and communicating clearly are important, everyone contributes.

Teams will want to know: what is the answer? Stress that one ***possible*** design for the sixth side of The Cube is shown below, but the point of the activity is to show there are other possibilities; that there are many ways to solve the problem; and to meet the challenge, we have to work together.

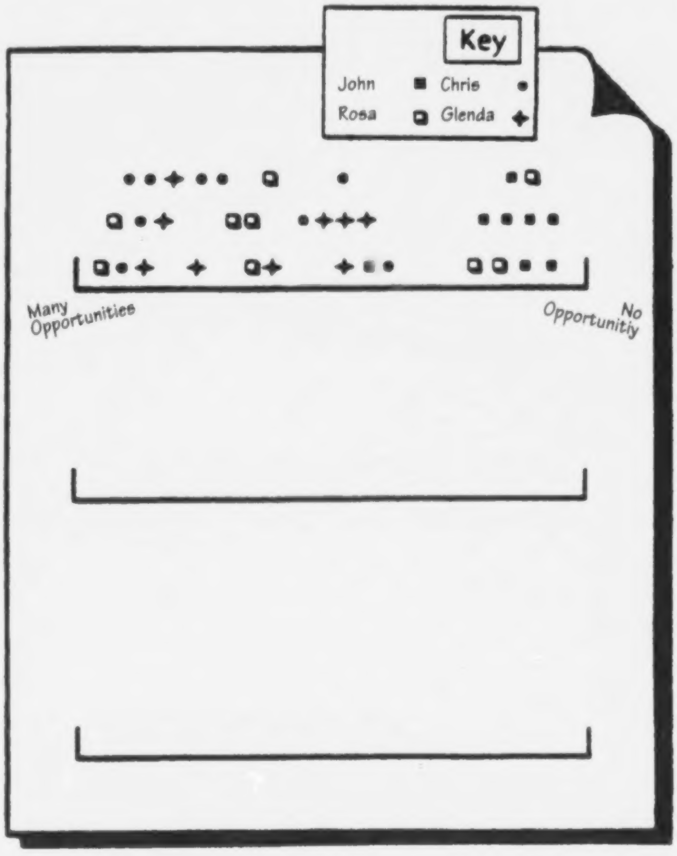


Guidelines for the Use of "Reflecting on Practice"

This activity provides concrete classroom examples (to be read) and a process for stimulating team members to think about and discuss various teaching practices and the ways in which they involve students.

1. Distribute, 1 copy of the next 4 pages to each. Allow time for everyone to individually read, reflect on, and place their responses on the continua (page 3).

2. Once everyone is finished, have them all come together to collate their placements, create a composite picture for all 3 continua and discuss the differences in their placements. (See an example format for creating a composite of the individual continua placements at the right) At this point, individual placements are challenged, justified, and modified.



3. On the back of page 4 is a set of blank continua. These can be used by the group to create more questions and continua. You may want to use this same process to reflect on and discuss the 4 examples with respect to the teacher's roles (e.g. To what extent does the teacher define the activity?), the degree of integration with multi-disciplinary outcomes, the amount of emphasis on process/skills vs. content (specific concepts, . . . or any other criteria that are of interest to the group).

Reflecting on Practice*

The purpose of the VINE Follow-Through Project is to create teams that will work together and enable teachers to follow-up on VINE schoolyard investigations in a way that will promote students' higher-level cognitive involvement with the plants, animals, habitats and ecological interactions on their schoolyards and enable the students to do more science.

The back of this sheet contains brief descriptions of four ways teachers build VINE investigations into their on-going curriculum. You may find some that are familiar and others that are not. We ask you to read, respond to and discuss them as a means of thinking about different approaches and the ways in which they each involve students.

This material was composed based on an activity of the same title created by TERC for their teacher workshops and reported in* **Hands On!, Spring 94.

I. Rosa

The children in my class need skills development – especially science process skills. So, before and after each outdoor investigation we do activities that give students opportunities to learn, practice and apply those skills. At the beginning of the year we spend time individually and as a class sorting classroom objects and learning to use a magnifying lens. Later on, students work in small groups to, for instance, organize the leaves they collected outdoors into categories, display their results and communicate their rationale to the other groups. By the end of the year's outdoor sessions, their skills are improved and they are more aware of what's living all around them.

II. Chris

My students and I use our outdoor discoveries as springboards for science learning. When we come back inside we always stay in our groups to discuss and compare what we discovered. First, within their groups, they compare their predictions with what they actually found. Then, as a class we compare observations made by each of the groups to see whether their groups' discoveries were similar or different. Consistently, I encourage them to defend their predictions, explain differences, and "give their reasons." My goal is to get students challenging and amplifying on each other's thinking. Frequently these discussions lead to fascinating questions that we pursue. For instance, this year's class was fascinated by the question: Where do the bugs go when they water the grass? We spent several weeks with different groups investigating various aspects of the question. This spring the students got into soil, mulch, and "litter critters." They asked about and investigated whether there were more critters where there was more mulch and whether there was more organic matter in the soil where there were more critters and mulch.

III. John

My students get so excited when they're outdoors doing VINE investigations! They discover and observe things living on the schoolgrounds that they've never noticed before. They refer to those experiences when we read and discuss material in our science text; it really makes the textbook come alive. I like to integrate the outdoor investigations into the rest of the curriculum by giving the children a chance to think about what they've done and to write. For example, they have written metaphors and similes comparing different bird species and have written descriptions of what their favorite bug looked like inside the zip-loc bag.

IV. Glenda

I want my students to learn some basic concepts. So I relate a different concept to each outdoor investigation. For example, after my class does *Plant Hunt*, they know how many species of plants there are on the schoolgrounds. Then I ask each group to identify 3 species: a species with the most plants on the schoolgrounds, a species with the fewest, and one with a medium number. Each group is responsible for figuring out as exactly as they can ***how many*** individual plants of their 3 species there are on our grounds and presenting their findings to the class. They work with their group during science class and before and after school. At the end of the week each group reports to the class. During our discussions, I introduce the term *population* and tell them how scientists define populations. They get a good feel for large and small populations, figure out some clever ways to estimate populations, and gain a hands-on understanding of what scientists do.

After reading the descriptions, consider the questions listed below. Respond to the questions by writing the name of each teacher on each continuum based on where you think that teacher's description should be placed.

To what extent do the students have opportunities to discuss their outdoor observations with peers?

no opportunities	many opportunities

To what extent do the students engage in higher-level thinking – e.g. constructing questions, planning, investigating, analyzing findings and evaluating own work, generating new ways of viewing things?

no higher-level thinking	much higher-level thinking

To what extent are the students doing science?

not doing science	doing a lot of science

Suggestions for Individual Interviews Regarding Habitat and Ecological Relationships

An interview taken from "Children's Ideas About Ecology," by John Leach, Rosalind Driver, et al, University of Leeds, United Kingdom. The purpose of this interview is to try to learn about each child's understanding and thinking — what he/she knows and how he/she explains a certain phenomenon in his/her own words. It's important to get each child to elaborate and tell you as much as possible.

Introduce yourself and get the child's first name. (You may want to use a cassette tape recorder so that you do not have to take notes. If so, point this out to the child.)

Explain to child

- you're doing a project and you need him/her to help you,
- you're interested in his/her **ideas,** and
- that there are no "right" or "wrong" answers.

Have pictures of about 20-30 organisms and an environment sheet spread out on a table.
(See examples.*)

DO NOT use the words **organism, plant,** or **animal**, as pupil's meanings for these terms may differ from the biological meanings.

Ask the child to select a group of 6 different things to live in "this place" (point out the environment) using the criterion that they would be **able to live together for a very long period of time, getting everything they needed.**

Allow time for selecting 6. (Note which 6 the child selects.)

Ask for each organism selected, **What does it need?, and Where does it get that from?**

When these have been explained for all 6, ask **which do you think there might be the most of?** and ask them to **explain why.**

Possible probes to get the child to tell you more

. . . anything else?

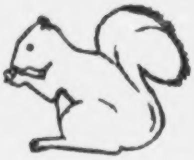
. . . and how does it do that?

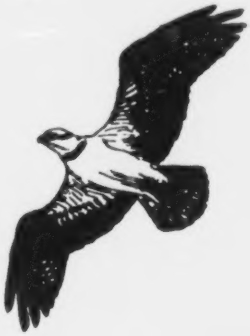
. . . how does that happen?

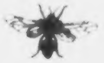
. . . does it help any of the other things?

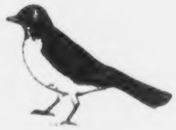
. . . could you tell me a bit more about that?

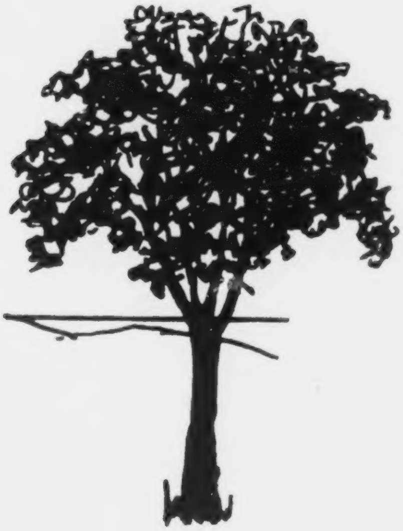
**The next two sheets of organisms can be cut up to give you a collection of organisms to present to the child. Please also find an "environment sheet" with land, water, sun, and clouds.*

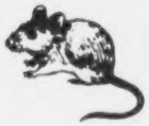


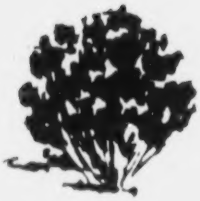


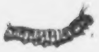


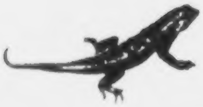


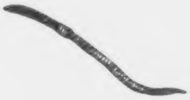


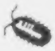


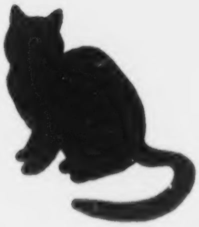


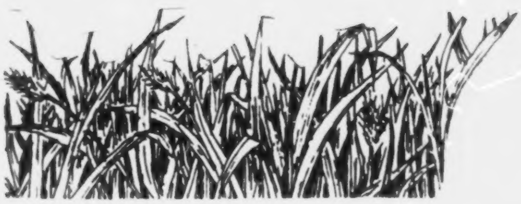


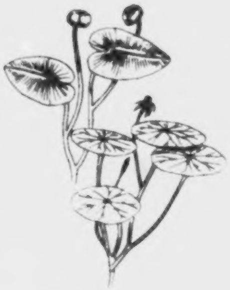


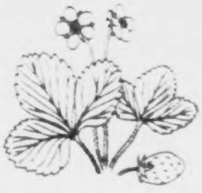


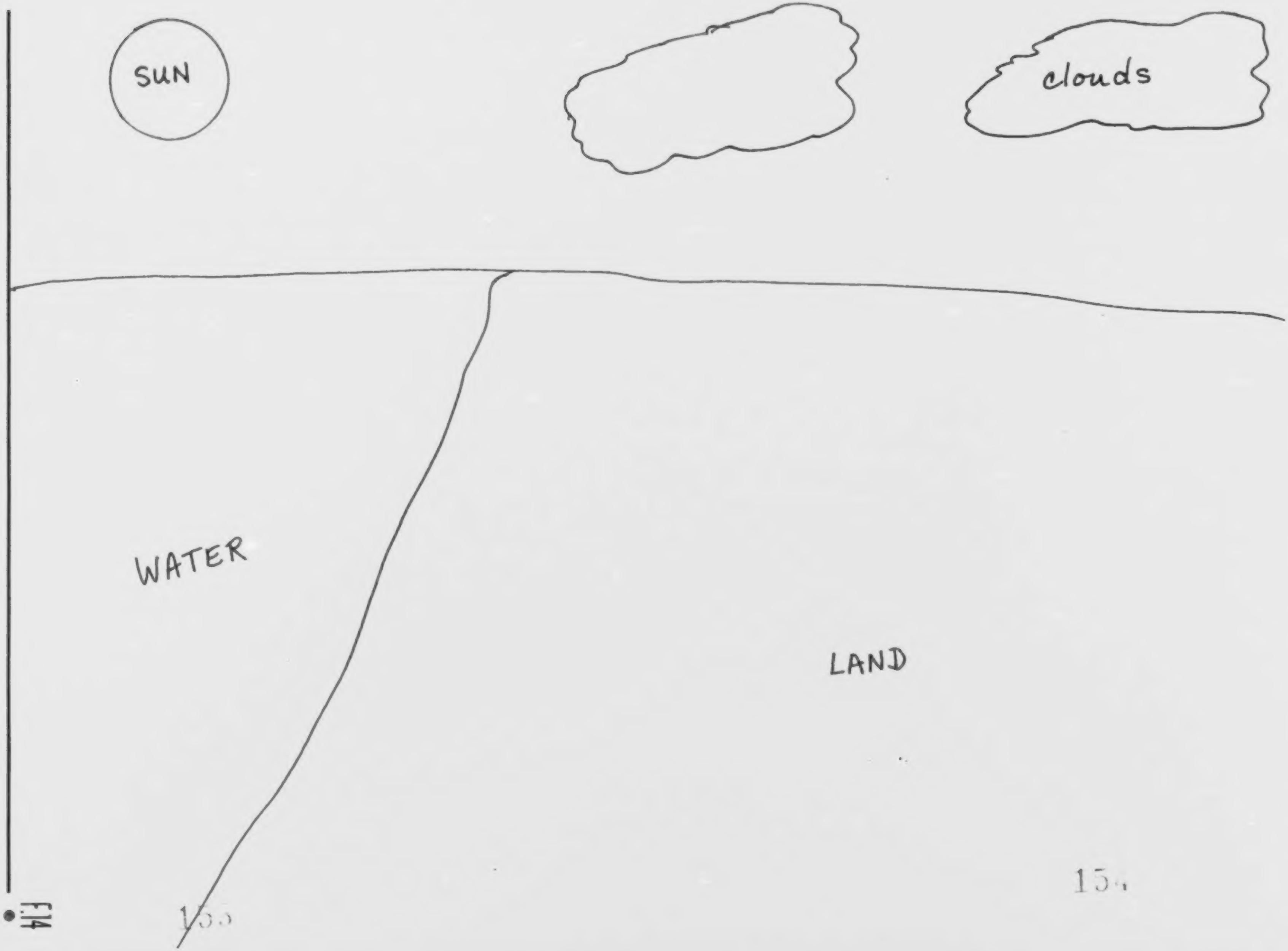











SUN
clouds
WATER
LAND

Suggestions for Individual Interviews Regarding Decomposition / Cycling of Matter

An interview taken from "Children's Ideas About Ecology," by John Leach, Rosalind Driver, et al, University of Leeds, United Kingdom. The purpose of this interview is to try to learn about each child's understanding and thinking — what he/she knows and how he/she explains a certain phenomenon in his/her own words. It's important to get each child to elaborate and tell you as much as possible.

Introduce yourself and get the child's first name. (You may want to use a cassette tape recorder so that you do not have to take notes. If so, point this out to the child.)

Explain to child

- you're doing a project and you need him/her to help you,
- you're interested in his/her **ideas**, and
- that there are no "right" or "wrong" answers.

Show the item (decaying leaf) or photo (rotting apple on ground under an apple tree) to the child. The item/photo you use should be something familiar to the children.

Ask: **what do you notice** about the leaf/apple. Tell me about what you notice.

For any differences they notice about this leaf/apple and the "normal" leaves/apples, ask them to **explain the differences.**

What do you think is making this happen?

If they suggest the leaf/apple is getting smaller, ask **where do you think the "stuff" from the leaf/ apple might go?**

If they use fairly scientific terms (like decay, rot, biodegrade, bacteria, decompose, compost, recycling, etc.), ask them to **explain what they mean.**

Other possible probes

How long do you think the changes/differences you've noticed might have taken?

. . . predictions about possible further changes?

. . . anything else?

. . . what happens then?

. . . why is that?

. . . can you explain that to me?

. . . help me understand how that happens.

Some sample interviews from "Children's Ideas About Ecology" in *International Journal of Science Education*, 1995-6; volume 17, issue 6, pages 721-32; volume 18, issue 1, pages 19-34; and, volume 18, issue 2 pages 129-141.

Interviewer: What do you think that these things that you've chosen [Fish, Crab, Frog] need to stay alive and healthy? How about number 18 [Fish]?
Pupil: They need small creatures to eat.

Interviewer: I see. What sort of creatures might it eat?
Pupil: It might eat baby crabs or frogs. (Age 5)

Interviewer: Do you think that any of these things help each other in any way?
Pupil: The tree helps the bird [number 39, Jay].

Interviewer: And how does it do that?
Pupil: Cos it helps . . . cos the bird can nest in it.

Interviewer: Oh, to give it a home?
Pupil: Yes.

Interviewer: I see. Do you think it helps any of the others in the same way?
Pupil: Yes, it shelters them. (Age 8)

Interviewer: Out of all these things that you've chosen, what do you think they might need to stay alive and healthy?
Pupil: Natural habitats.

Interviewer: I see, could you tell me a bit more about that?
Pupil: Cos where humans are building buildings and things, they are destroying all the habitats and things like that.

Interviewer: Oh, I see, so they'll need places like this place [points to picture] to live, and if people build at all, then that will damage that. Anything else that they need?
Pupil: Owls and eagles, they need things to eat.

Interviewer: Oh, I see, what sorts of things?
Pupil: Smaller birds [points to number 12, Swallow]. (Age 13)

Interviewer: . . .And what makes you think that there will be most owls in the trees?
Pupil: Cos they come out at night and there's hardly anything to eat them. And their enemies aren't out at night so I think that there's most of them. (Age5)

Interviewer: I see . . . and why do you think there might be most of that one, then?
Pupil: Because they like it on the leaves, caterpillars. (Age 5)

. . .if there are too many birds there won't be any insects, cos they get eaten a lot by other animals and stuff, and there needs to be loads of them to survive. (Age 16)

What Crucial Roles Must Be Filled?

The following list describes some of the roles that might be filled by various members as you build your team. Keep in mind that while team members may be fully committed, team dynamics are fluid since individuals may have to miss occasional meetings. Thus, you will find that different members contribute different things at different times. Your team can start with this list to see if these roles are being filled or brainstorm who would like to *initially* fill these roles.

Role	**Function**	**Do You Have...?**
Seer	Reminds the group of the Big Picture or the larger goal of the project.	yes no
Focuser	Keeps the group on task — is able to engage as part of the group, yet is mindful of time constraints and purpose of the task.	yes no
Humorist	Lightens the hard spots of the task through humor, stories.	yes no
Recorder	Records information during the meetings.	yes no
Disseminator	Disseminates meeting minutes and other information needed by the team.	yes no
Synthesizer	Extrapolates information, finds connections and links between ideas being contributed and puts it all together.	yes no
Politician	Understands the current issues, trends in education, curriculum standards at the national, state, and district levels that impact the project.	yes no
Communicator	Acts as a liaison to other teams and/or the project director.	yes no
Techspert	Coordinates phone conferences, group e-mail, faxes (an extension of the communication function).	yes no
Provider	Identifies the needs of the team and its members and helps identify necessary resources, funding, materials.	yes no
Facilitator	Thinks about creature comforts and ways to meet them (e.g., food, comfortable meeting places).	yes no
Validator	Encourages team members in their tasks, validates what members do and what individual members contribute to the group.	yes no
Organization liaisons	Each shares information within own organization (e.g. district, nonformal education, university, business).	yes no
Manager	Provides rationale for the task, works with the team to establish expectations, timelines, goals, monitors progress, responds to the needs of the team members, and shares power.	yes no
Champion	Initiates contacts, connects potential team members at program beginning, and/or champions the program within his/her own institution.	yes no

Work Styles Profile*

Note: This activity is quite complex and requires a facilitator with excellent people skills. Depending on group size, the activity can take anywhere from an hour and fifteen minutes to an hour and forty-five minutes - the larger the group, the more time this will take. The point of the Work Styles Profile is to understand and come to value the diversity of work styles in the group. Thus, it is best to have a large number of people engaged in the activity; if you have too few people, you may not have some of the work styles represented. Since the fun part is to see the interactions of the different work styles, it may be worthwhile to recruit others to engage in the activity with your "team" (secretary, colleagues, significant others).

Purpose:	Team building Understand personal work styles Value diversity
Time required:	5 minutes to introduce the activity 5 - 10 minutes to complete the Descriptive Inventory 5 - 10 minutes to complete the Scoring Graph 15 - 20 minutes to develop the Work Style Caricatures 15 - 20 minutes for teams to develop Group Work Style Profiles 30 - 45 minutes to debrief
Materials:	Copies of Descriptive Inventory for each person Copies of Scoring Graph for each person 4 - 8 pieces of poster paper for Group Profile presentations Extra poster paper for note taking Pencils or pens Marking pens Masking tape Camera for taking pictures of Group presentations (optional)

Getting ready:
Do the complete activity yourself first (this will take you about 20 minutes) so that you know what your own Work Style Profile is and can refer to yourself during the activity. Tape a couple of sheets of poster paper to the wall for note taking.

Procedure:
Explain that the activity involves gaining a deeper understanding of one's own personal work style and how that work style fits into teamwork.

Enter the activity with lots of humor; people may be nervous about revealing themselves and how they think or act. Reassure them by explaining that this is to be a light-hearted look at their personal work styles and is not meant to be a heavy psychological, scientific analysis of personality and that work style is sometimes situational.

**This material was composed based on a workshop conducted by Carolyn Gellerman, The Boeing Company.*

Distribute a pen or pencil and a copy of the Descriptive Inventory to each person.

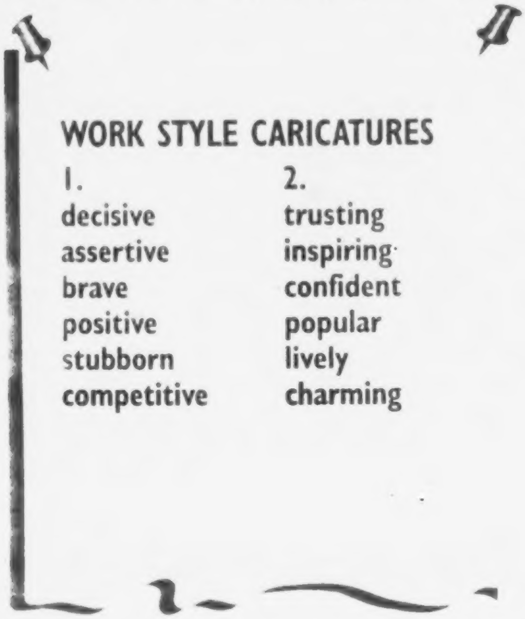
Direct them to check one word or phrase in each box that best describes them. This is a "forced choice" activity; you can only choose one word in each box. Tell them that they shouldn't think too much about which word or phrase they should check – they should go with their first reaction.

As soon as individuals complete the Descriptive Inventory give them the Scoring Graph and ask them to follow the directions to complete the graphs.

When everyone has completed both a Descriptive Inventory and a Scoring Graph, tell them that together you are going to develop "caricatures" for the different work styles and that these, of course, are exaggerations. This section, which characterizes the behaviors of the various work styles, needs to be facilitated with humor and kept very light. You don't want folks to get defensive about their work style but to celebrate it and note the wonderful contributions each particular work style has for a team. As the facilitator, refer to your own style often in a humorous way and be willing to reveal yourself.

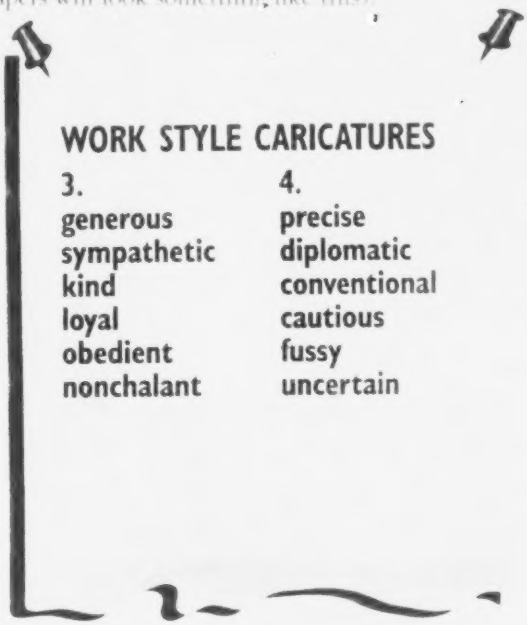
Ask the group to give four or five descriptive words for someone whose longest bar was column 1 (look back on the Descriptive Inventory). Write the number 1 on a poster paper with the title: Work Style Caricatures and note those words under the number 1.

Do the same for columns two through four. (The poster papers will look something like this).



WORK STYLE CARICATURES

1.	2.
decisive	trusting
assertive	inspiring
brave	confident
positive	popular
stubborn	lively
competitive	charming



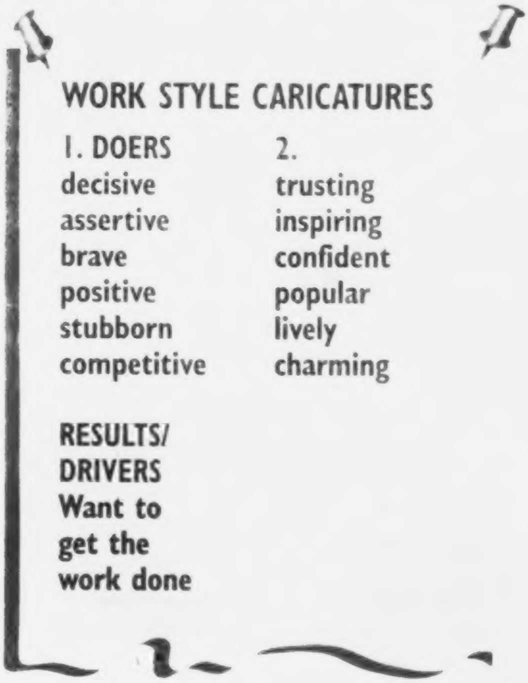
WORK STYLE CARICATURES

3.	4.
generous	precise
sympathetic	diplomatic
kind	conventional
loyal	cautious
obedient	fussy
nonchalant	uncertain

Tell the group that folks with the tallest shading in **column one** can be labeled **"Doers"** and write Doer next to the number 1 on the poster paper.

Doers:
- are task oriented,
- like to direct the action,
- don't like to share the TV remote control,
- are present time frame oriented,
- act swiftly.

Tell the group that for Doers, the maximum need is for **Results** and write the word Results under the first column of words. Ask the group since Doers can be very task driven, how might they be perceived (pushy, dominating)? Emphasize that this isn't how they really are – they just ***want to get the work done.*** They can be the **Drivers** of a group – write this next to Results. Your poster paper will look something like this.

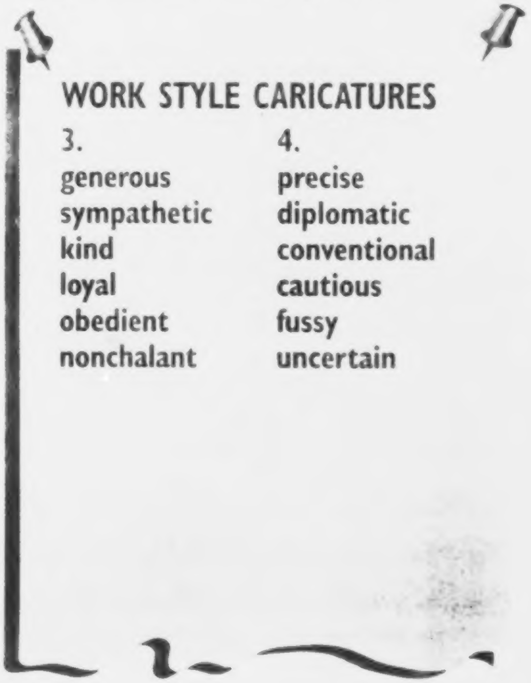


WORK STYLE CARICATURES

1. DOERS
decisive
assertive
brave
positive
stubborn
competitive

RESULTS/
DRIVERS
Want to
get the
work done

2.
trusting
inspiring
confident
popular
lively
charming



WORK STYLE CARICATURES

3.
generous
sympathetic
kind
loyal
obedient
nonchalant

4.
precise
diplomatic
conventional
cautious
fussy
uncertain

Tell the group that folks with the tallest shading in **column two** can be labeled **"Expressives"** and write Expressive next to number two on the poster paper.

Expressives:
- are people oriented,
- like to be in the middle of the action,
- would rather tell stories than watch TV – forget the remote control,
- are future time frame oriented,
- act on intuition.

Tell the group that for Expressives, the maximum need is for **Excitement** and write the word Excitement under the second column of words. Ask the group since Expressives can be very animated and dramatic, how might they be perceived (undisciplined, egotistical)? Emphasize that this isn't how they really are – they are just ***enthusiastic about the work.*** They can be the **Intuitors** of a group – write this next to Excitement.

Continue with column three and column four. For the sake of brevity, these are summarized below.
Amiable – column three

Amiables:
- are people oriented,
- ike to support the action,
- give you the TV remote control,
- are present time frame oriented,
- act cooperatively.

Maximum need – **Acceptance**
May be perceived as conforming, unsure.
They just really ***want to work cooperatively.***
The **Feelers** of a group

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Analytics – column four

Analytics:
- are information oriented,
- like to contribute data to the action,
- want to know how many stations you get with the TV remote control,
- are historic time frame oriented,
- act on data.

Maximum need – **Accuracy**
May be perceived as picky, critical.
They just really ***want the correct data to do the work***.
The **Thinkers** of a group.

After developing the caricatures, your poster paper should look something like this.

WORK STYLE CARICATURES

1. DOERS	2. EXPRESSIVES
decisive	trusting
assertive	inspiring
brave	confident
positive	popular
stubborn	lively
competitive	charming
RESULTS/ DRIVERS	EXCITEMENT/ INTUITORS
Want to get the work done	Want to be enthusiastic about the work

WORK STYLE CARICATURES

3. AMIABLES	4. ANALYTICS
generous	precise
sympathetic	diplomatic
kind	conventional
loyal	cautious
obedient	fussy
nonchalant	uncertain
ACCEPTANCE/ FEELERS	ACCURACY/ THINKERS
Want to work cooperatively	Want the correct data to do the work

Ask people with similar long bars to gather in groups. Thus, all analytics form a group, expressives form a group, etc.

Give them poster paper and marking pens and, referring to their group's work style, ask them to take the next 15 - 20 minutes to develop their Group Work Style Profile. They are to discuss and record:

How We Help A Team
How We Might Hinder A Team
How We Might Be Misperceived
Song/slogan/poem/saying That Captures The Essence Of Our Work Style

When the groups have completed their Group Work Style Profile, have them present their profiles to each other. You might want to take photographs while they present.

Make sure people understand that the point of the Work Style Profile activity is to:
- understand and value the work style diversity that exists within the team;
- see that every style makes valuable contributions to teamwork;
- realize that everyone has the responsibility to "fill in the gaps" that may exist on a team.

Descriptive Inventory*

Work Style Profile

Check the word or phrase in each set that is most like you.

1.__ Competitive 2.__ Joyful 3.__ Considerate 4.__ Harmonious	1.__ Tries new ideas 2.__ Optimistic 3.__ Wants to please 4.__ Respectful	1.__ Will power 2.__ Open-minded 3.__ Cheerful 4.__ Obliging	1.__ Daring 2.__ Expressive 3.__ Satisfied 4.__ Diplomatic
1.__ Powerful 2.__ Good mixer 3.__ Easy on others 4.__ Organized	1.__ Restless 2.__ Popular 3.__ Neighborly 4.__ Abides by rules	1.__ Unconquerable 2.__ Playful 3.__ Obedient 4.__ Fussy	1.__ Self-reliant 2.__ Fun-loving 3.__ Patient 4.__ Soft-spoken
1.__ Bold 2.__ Charming 3.__ Loyal 4.__ Easily led	1.__ Outspoken 2.__ Companionable 3.__ Restrained 4.__ Accurate	1.__ Brave 2.__ Inspiring 3.__ Submissive 4.__ Timid	1.__ Nervy 2.__ Jovial 3.__ Even-tempered 4.__ Precise
1.__ Stubborn 2.__ Attractive 3.__ Sweet 4.__ Avoids	1.__ Decisive 2.__ Talkative 3.__ Controlled 4.__ Conventional	1.__ Positive 2.__ Trusting 3.__ Contented 4.__ Peaceful	1.__ Takes risks 2.__ Warm 3.__ Willing to help 4.__ Not extreme
1.__ Argumentative 2.__ Light-hearted 3.__ Nonchalant 4.__ Adaptable	1.__ Original 2.__ Persuasive 3.__ Gentle 4.__ Humble	1.__ Determined 2.__ Convincing 3.__ Good-natured 4.__ Cautious	1.__ Persistent 2.__ Lively 3.__ Generous 4.__ Well-disciplined
1.__ Forceful 2.__ Admirable 3.__ Kind 4.__ Non-resisting	1.__ Assertive 2.__ Confident 3.__ Sympathetic 4.__ Tolerant	1.__ Aggressive 2.__ Life-of-party 3.__ Easily fooled 4.__ Uncertain	1.__ Eager 2.__ High-spirited 3.__ Willing 4.__ Agreeable

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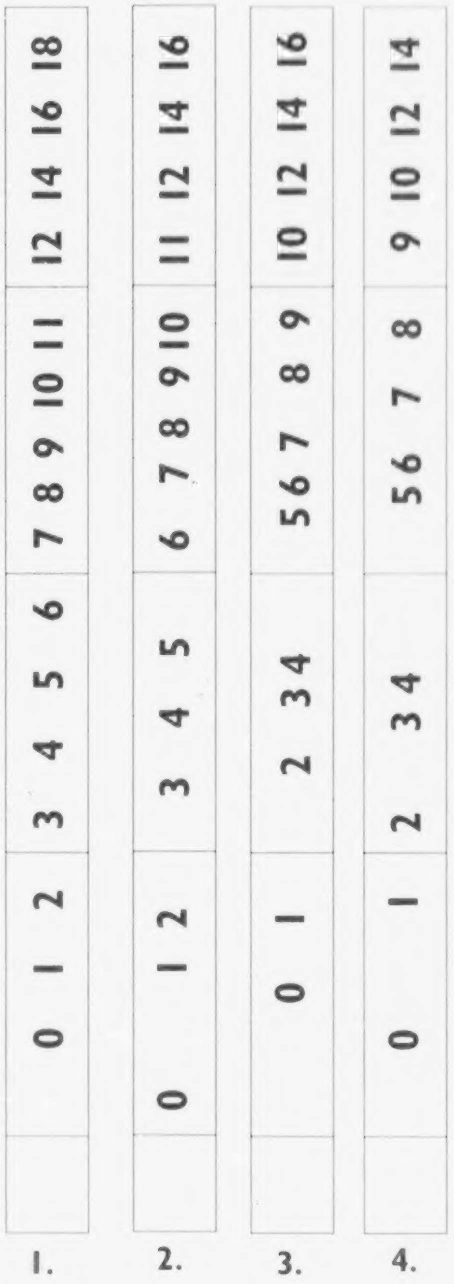
* *Source: Carolyn Gellerman, The Boeing Company*

Scoring Graph*

Work Style Profile

Directions:

- Count the number "ones" that you checked. Write that number in the empty square at the bottom of column number one. Do the same with the numbers two, three, and four.
- For the first column, draw a line through the number within the column that corresponds with your total number of "ones." This is the end line of your bar graph for the first column.
- Beginning at the bottom of the column, shade in the column up to your end line.
- Do the same for the second, third, and fourth columns.
- The column in which your shading is tallest, is your predominant work style. Your backup work style is the column in which your shading is second tallest.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0 1 2 3 4 5 6 7 8 9 10 11 12 14 16
0 1 2 3 4 5 6 7 8 9 10 12 14 16
0 1 2 3 4 5 6 7 8 9 10 12 14
1.
2.
3.
4.

---

*Source: Carolyn Gellerman, The Boeing Company

Airplane*

Note: while this activity looks complicated, it is really very simple. The facilitator's job is to give the directions, ensure that the participants are following directions, ensure that no one is talking to one another while their "airplane" is flying, and to facilitate the debriefing session. There will be many "ahas" during the debriefing session and lots of laughter as people discover their assumptions have probably been incorrect and discuss their feelings about the positions they occupied on the "airplane."

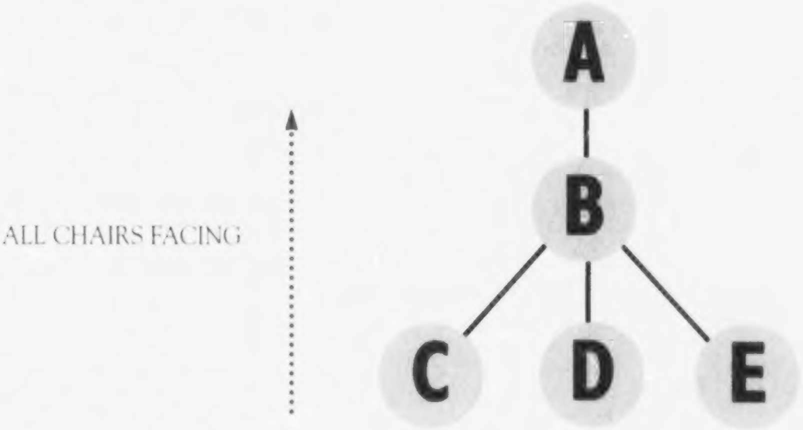
Purpose: Teambuilding
Develop insight into the importance of communication

Time required: 5 minutes to introduce the problem
10 minutes to solve the problem
30 - 45 minutes to debrief

Materials: Copies of Airplane Directions A - E
Copies of Job Satisfaction Survey
Scratch paper for writing notes (quarter sheets of paper are fine; about 10 sheets per person)
Pencils or pens for each person

Getting ready:
You need at least 10 people in order for this activity to be effective. "Airplanes" will hold 5 people apiece so you need multiples of 5 folks. If there are "extra" people, have them be observers and take notes on airplane operation. People outside your "team" may be recruited to participate (e.g. secretary, colleague, significant other).

Have "airplane flyers" move their chairs into the configuration shown below.



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*This material was composed based on a workshop conducted by Carolyn Gellerman, The Boeing Company.

Explain that the person in the "A" position is the pilot; "B" position is the Co-pilot; "C," "D," and "E" positions are the Passengers. The job of all the folks on an airplane is to solve a problem and by solving the problem, they will have landed their airplane safely.

> *** Note: the "problem" is to identify the common symbol that each of them has on their Airplane Direction sheet. But only the pilot has the problem defined. Do not tell them this.***

Distribute about 10 pieces of scratch paper to each person and a pencil or pen.

Explain that there is to be NO TALKING during the activity and NO CONTACT between the folks on an airplane (e.g. they can't turn around in their chairs and point). Their ONLY method of communication is by memo and the memos are to be notes they write or receive on the pieces of paper they have.

Explain that the Pilot, "A," can only send and receive memos from the Co-pilot, "B". The Co-pilot can send and receive memos from any person on the airplane. Passengers "C," "D," and "E" can only send and receive memos from the Co-pilot. There is to be no other line of communication except those. The participants may be anxious that they won't remember who they are supposed to be communicating with; reassure them that the Airplane Directions that they will be getting from you, will tell them with whom they can communicate.

Explain that they have 10 minutes to solve their problem and land their plane safely. When they think they have solved the problem, the Pilot is to raise his or her hand and show you their written answer and you will tell them whether they have landed safely or not. (The correct answer is ⊙).

Distribute the Airplane Directions in the following manner:

> Pilot "A" receives only a copy of Airplane Directions A
>
> Co-pilot "B" receives only a copy of Airplane Directions B
>
> Passenger "C" receives only a copy of Airplane Directions C
>
> Passenger "D" receives only a copy of Airplane Directions D
>
> Passenger "E" receives only a copy of Airplane Directions E

Tell them to proceed following their airplane directions. Start timing.

About 5 minutes into the activity, give them a "warning" that they only have 5 minutes left to land their airplane safely. You *want* to raise the anxiety level; thus, at various times in the remaining five minutes you can tell them things like: "The yellow emergency light is flashing;" "Oxygen masks have dropped from the ceiling;" "Make sure your seat belts are fastened;" etc.

As airplanes land safely, distribute to the members of those airplanes a Job Satisfaction Survey to complete.

After ten minutes, call a halt to the activity. Some airplanes will have crashed; they won't have solved the problem within the allotted time. Give the members of those airplanes a Job Satisfaction Survey to complete also.

The debrief:

Have airplanes rearrange their chairs into a circle so they can talk with one another.

Give them 10 minutes to discuss the Job Satisfaction Survey. It is during this time that they will discover (if they haven't already discovered it) that only the Pilot had the problem defined.

After 10 minutes, debrief as an entire group with the following questions:

How did the different positions on the airplane feel about their jobs?
(Start with Pilots and proceed to Passengers)

Why did you feel that way?

Who was doing the most work?

What would have alleviated your anxieties?

Are there real-life examples of this type of communication?

How could you reconfigure the airplane to facilitate problem solving?

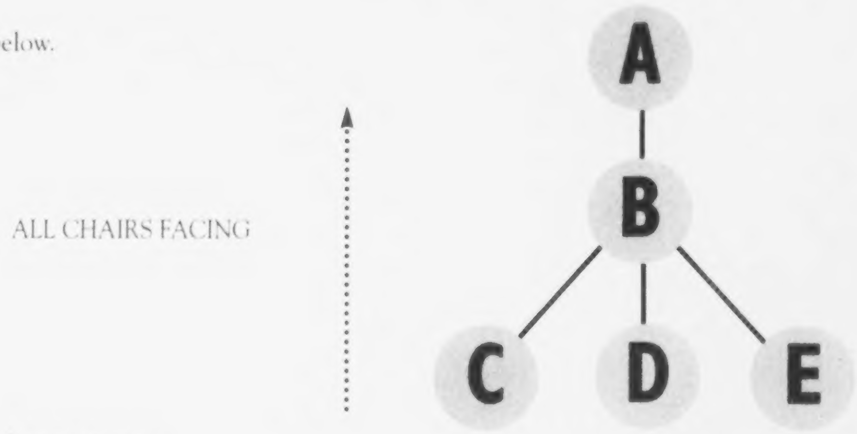
What did you learn from this activity?

Make sure people understand that the point of Airplane is:

- free and open communication must exist among all members of the team in order to function well;
- team members can't assume that others have the same information they do;
- in a reconfigured airplane, there is no pilot but everyone is equal with different pieces of information important to the group.

Airplane Directions - A

Your airplane is configured as below.



Pilot A and Co-pilot B may exchange memos.

Passengers C, D, E may exchange memos with Co-pilot B only.

No other communication is allowed.

You may not give or show your directions to any other person.

If you have a question, raise your hand.

Instructions:

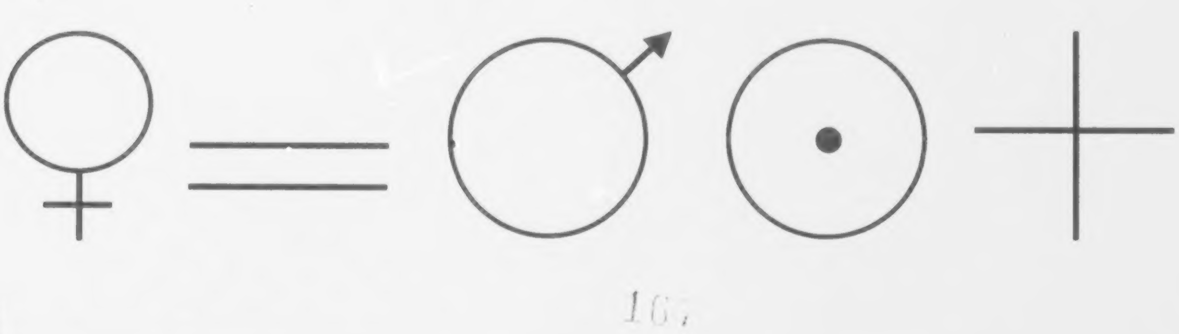
You are the Pilot. The Co-pilot communicates with you and the passengers.

Each of you has five symbols printed on the Airplane Direction sheet.

There is a total of six familiar symbols used in the activity. In order to land your airplane safely, you must find out which one of the six symbols is held in common.

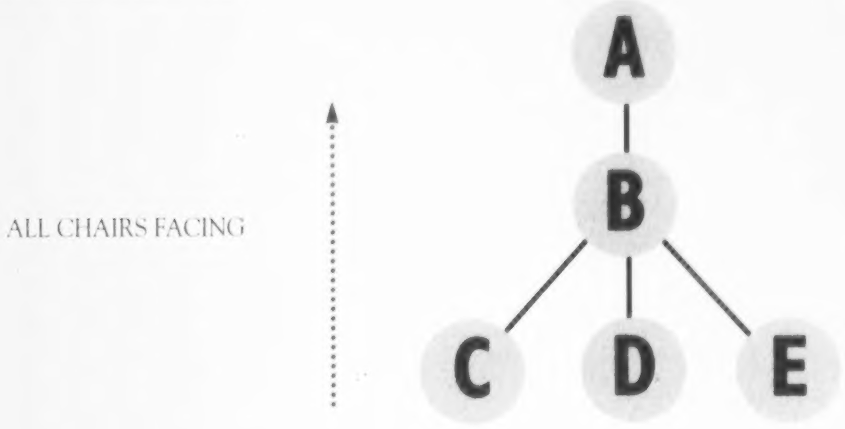
You may communicate by memo only with your Co-pilot, B.

When you think you have identified the common symbol, raise your hand.



Airplane Directions - B

Your airplane is configured as below.



You are the Co-pilot.

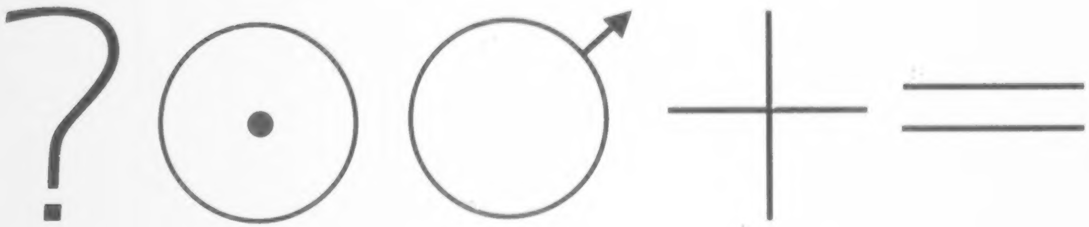
You can communicate by memo with the Pilot, A.

Passengers C, D, and E may communicate with you only.

No other communication is permitted.

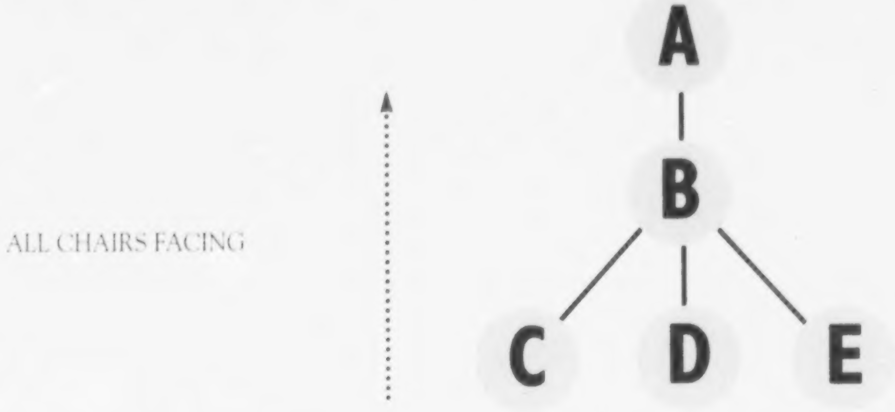
You may not give or show your Airplane Directions to any other person.

If you have a question, raise your hand.



Airplane Directions - C

Your airplane is configured as below.



You are Passenger C.

You can communicate by memo with the Co-pilot, B, only.

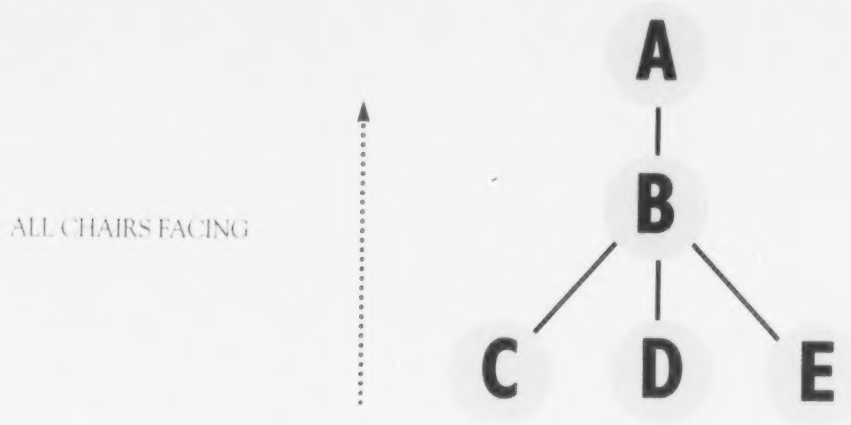
No other communication is permitted.

You may not give or show your Airplane Directions to any other person.

If you have a question, raise your hand.

Airplane Directions - D

Your airplane is configured as below.



You are Passenger D.

You can communicate by memo with the Co-pilot, B, only.

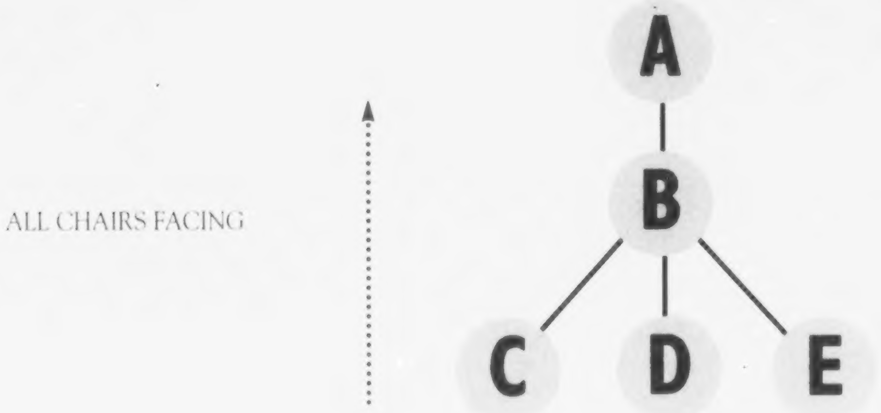
No other communication is permitted.

You may not give or show your Airplane Directions to any other person.

If you have a question, raise your hand.

Airplane Directions - E

Your airplane is configured as below.



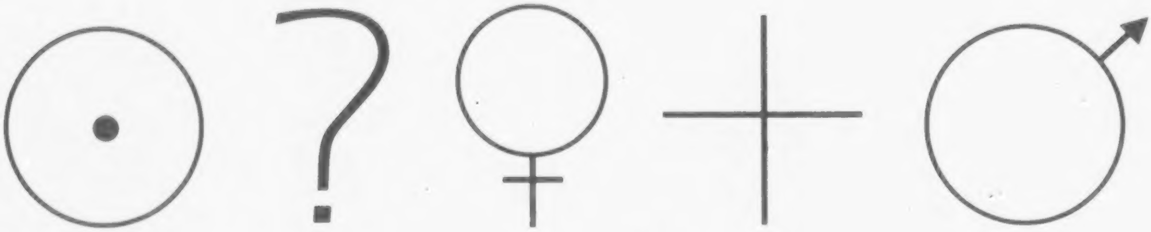
You are Passenger E.

You can communicate by memo with the Co-pilot, B, only.

No other communication is permitted.

You may not give or show your Airplane Directions to any other person.

If you have a question, raise your hand.



Job Satisfaction Survey

Based on your experience in your airplane, please respond to the following questions. Complete the survey individually and then share your responses with your airplane members.

1. Did you land your airplane safely? yes no

2. Did you know what the problem was in order to land your airplane?

   yes no

3. How much were you made to feel that you were helping to solve the problem and land your airplane? Please circle the number which indicates how much you felt you were helping.

   not at all very much

   1 2 3 4 5

4. To what extent did you feel your skills and abilities were used to solve the problem and land your airplane? Please circle the number which indicates how you felt.

   not at all very much

   1 2 3 4 5

5. To what extent did you feel a responsibility for landing your airplane?

   not at all very much

   1 2 3 4 5

6. Select three feeling words from the following list that describes your feelings while you were trying to land your airplane.

   Happy
   Bored
   Frustrated
   Angry
   Suspicious
   Respected
   Powerless
   Elated
   Annoyed
   Confused
   Unhappy
   Powerful
   Hurt
   Disengaged
   Stressed

7. What are some other "feeling" words that your group would add to the list above?

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Reading List

*Anderson, Charles W. (1987) Strategic Teaching in Science. *Strategic Teaching and Learning: Cognitive Instruction in the Content Areas.* Oak Brook, IL.: North Central Regional Education Laboratory.

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Harvard-Smithsonian Center for Astrophysics (Producer). (1995) Environmental Science: Taking a Risk. *Private Universe Teacher Workshop Videos* (90 min.) Washington, DC: The Annenberg/CPB Math and Science Collection, Corporation for Public Broadcasting. Available through 1-800-965-7373 or fax 802-864-9846.

*Kober, Nancy. (1993) What Instructional Methods Support Scientific Thinking and Problem Solving?. *EdTalk: What We Know About Science Teaching and Learning.* Washington, DC.: Council for Educational Development and Research (now National Education Knowledge Industry Association Communications).

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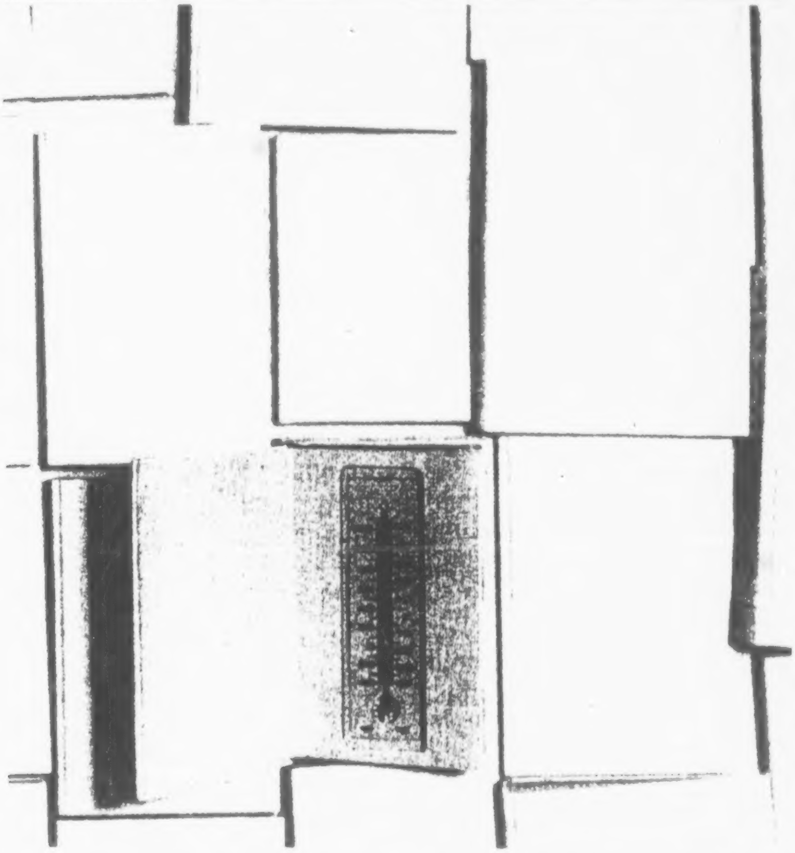
Teaching for Conceptual Change: Confronting Children's Experience*

If Deb O'Brien had begun her lesson on heat in the usual way, Messrs. Watson and Konicek point out, she might never have known how nine long Massachusetts winters had skewed her students' thinking.

BY BRUCE WATSON AND RICHARD KONICEK



FOR NINE winters, experience had been the children's teacher. Every hat they had worn, every sweater they had donned contained heat. "Put on your warm clothes," parents and teachers had told them. So when they began to study heat one spring day, who could blame them for thinking as they did?

"Sweaters are hot," said Katie.

"If you put a thermometer inside a hat, would it ever get hot! Ninety degrees, maybe," said Neil.

"Leave it there a long time, and it might get to a hundred. Or 200," Christian added.

If Deb O'Brien had begun her lesson on heat in the usual way, she might never have known how nine long Massachusetts winters had skewed her students' thinking. Her fourth-graders would have learned the major sources of heat, a little bit about friction, and how to read a thermometer. By the end of two weeks, they would have been able to pass a simple test on heat. But their preconceptions, never having been put on the table, would have continued, coexisting in a morass of conflicting ideas about heat and its behavior.

However, like a growing number of educators at all levels, O'Brien periodically teaches science for "conceptual change." Her students, allowed to examine their own experiences, must confront

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*Watson, Bruce and Richard Konicek. (1990) *Teaching for Conceptual Change: Confronting Children's Experience.* **PHI DELTA KAPPAN**. 71, May: 680-685. Reprinted with permission of the **PHI DELTA KAPPAN.** Copyright 1990 by **PHI DELTA KAPPAN.** All rights reserved.

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the inconsistencies in their theories. In the process they find the path toward a deeper understanding of heat, have a great time with science, and refine their thinking and writing skills.

O'Brien began with the simple question, "What is heat?" Using journals and the chalkboard to record their ideas, the students, with O'Brien's help, wrote down their "best thinking *so far*" on the subject of heat. Heat came from the sun, they wrote. And from our bodies. But when Owen spoke about the heat in sweaters, everyone else agreed. Sweaters were *very* hot. Hats, too. Even rugs got "wicked hot," the children said. Sensing the first of many naive conceptions, O'Brien stopped them and said the magic words in science, "Let's find out."

For two whole days the testing went on. Experience, that most deceptive of teachers, had to be met head on. With their teacher's help, Christian, Neil, Katie, and the others placed thermometers inside sweaters, hats, and a rolled-up rug. When the temperature inside refused to rise after 15 minutes, Christian suggested that they leave the thermometers overnight. After all, he said, when the doctor takes your temperature, you have to leave the thermometer in your mouth a long time. Folding the sweaters and hats securely, the children predicted three-digit temperatures the next day.

When they ran to their experiments first thing the next morning, the children were baffled. They had been wrong. Now they'll change their minds, and we can move on, O'Brien thought.

But experience is an effective, if fallible, teacher. The children refused to give up. "We just didn't leave them in there long enough," Christian said. "Cold air got in there somehow," said Katie. And so the testing went on.

CONCEPTUAL CHANGE AND HOW IT GREW

Since the late 1970s, the notion of "conceptual change" has been a pedagogical football among science educators. Arguing that reading and observing scientific principles will not alone move the mountain of "alternative frameworks" about science that children bring to the classroom, that even hands-on activities allow such thinking to go undetected, teachers are beginning from square one, helping children construct their own models of scientific principles.

If children base their thinking on what they have seen and felt, then their experience must be structured to challenge their erroneous beliefs. If alternative views of scientific principles are not addressed, they can coexist with "what the teacher told us" and create a mishmash of fact and fiction. When studying astronomy, for instance, if no one brings up the common belief in astrology, children can learn every available fact about the planets and still go away thinking that Venus somehow controls their destiny. But if each child is given a chance to test his or her own model of the universe and find its limits, then a deeper understanding, without the naive conceptions, can result.

As early as the 1920s John Dewey emphasized science as inquiry, and Gerald Craig in his landmark dissertation spoke eloquently in favor of teaching science as investigation.[1] Yet the texts and curricula of the 1950s told a different story. Science texts were reading books, punctuated by predigested demonstrations of various facts embedded in such obvious questions as, "Does air have weight?"

When the orbiting Sputnik I beeped to the world that the U.S. space program was second best, the golden age of science education began. Millions of dollars were made available for writing and implementing new science curricula. The National Defense Education Act (NDEA) of 1958 provided matching federal dollars for equipment purchased by schools. Probably most important, the new emphasis on science education gave scientists, psychologists, and educators the opportunity to combine efforts on a single task: improving science and mathematics education for all children.

Drawing on the work of such psychologists as Jerome Bruner, Robert Gagne, and Jean Piaget,[2] the emphasis in science education finally caught up with what Dewey, Craig, and others had been saying since the 1920s. Science is an inquiry-oriented subject; subjects should be taught and ultimately learned according to the structure of the discipline; children and how they learn should be at the center of the teaching of any subject.

> Sensing the first of many naive conceptions, O'Brien stopped them and said the magic words in science, "Let's find out."

Since the early 1960s science educators have tried to follow these tenets through times of financial feast and famine. The plethora of programs – from the 1960s: Science A Process Approach (SAPA), Science Curriculum Improvement Study (SCIS), Minnesota Mathematics and Science Teaching Project (MINNEMAST), Elementary Science Study (ESS); from the 1970s: Conceptually Oriented Program in Elementary Science (COPES), Science 5/13, Nuffield; and from the 1980s: Great Explorations in Math and Science (GEMS), TOPS, Activities in Integrating Math and Science (AIMS) – all subscribe, with mild variations, to the basic philosophies described above. Children are the focus, and science is viewed as a combination of content, process, skills, attitudes, and values.

These alphabetic programs, later published by commercial firms, made a modest impression on the market. Their ideas and activities were incorporated into such commercial texts as *Space, Time, Energy, and Matter (STEM)*, but even these books have made no more than a ripple in the ocean of school science. The latest generation of texts once again pays lip service to science as an inquiry-oriented discipline, but the books themselves resemble their ancestors of the 1950s more than they do those produced during that brief "golden age." Today's texts, which have the greatest influence on how science is taught in American schools, have come almost full circle, and teachers who rely primarily on them are little closer to teaching science as inquiry than were their counterparts in the 1920s. In too many classrooms across the U.S., science is still taught as a cohesive set of facts to be absorbed, and children are viewed as blank slates on which teachers are to write.

But in the last 20 years such people as David Ausubel, Joseph Novak, Rosalind Driver, John Clement, and others have begun to ask different questions about children's learning.[3] Cognitive psychol-

> The substitution of one theory for another is not as easy as erasing the chalkboard. Certain preconditions must exist.

ogy and neo-Piagetian philosophy agree that knowledge, for both children and adults, grows and changes in very interesting ways. Learners bring their idiosyncratic and personal experiences to most learning situations. These experiences have a profound effect on the learners' views of the world and a startling effect on their willingness and ability to accept other, more scientifically grounded explanations of how the world works. Teachers who take a personal, adaptive view of knowledge are known as *constructivists* because their model of learning posits that all knowledge is constructed by the individual in a scheme of accommodation and assimilation.

Deb O'Brien is such a teacher. Her students, actively constructing their conceptual understanding of heat and its behavior, eagerly tackled their surprising data with yet another experiment.

THE INVESTIGATION HEATS UP

When the shock of the room temperature readings on the bundled-up thermometers wore off, the children went at it again. If, as they insisted, cold air had seeped inside the clothes overnight, what could they do to keep it out? While O'Brien would have preferred to focus on one variable at a time, the children's discussion brought out other naive conceptions. Remembering attics and cars, some of them said that closed spaces were hot. "How could you test that?" O'Brien wondered. Neil decided to seal the hat, with a thermometer inside, in a plastic bag. Katie chose to plug the ends of the rug with hats. Others placed sweaters in closets or in desks, far away from the great gusts of cold air they seemed to think swept through their classroom at night. With their new experiments snugly in place, time – that old heat maker – was left to do its job.

On Wednesday morning the children rushed to examine their experiments. They checked their deeply buried thermometers. From across the room, they shared their bewilderment. All the thermometers were at 68 degrees Farenheit. Confused, they wrote in their journals.

"Hot and cold are sometimes strange," Katie wrote. "Maybe [the thermometer] didn't work because it was used to room temperature."

Owen didn't know what to write, and Christian wrote simply, "I don't know why."

Meanwhile, O'Brien kept her own journal. This was one of her first attempts at teaching through conceptual change, and she wondered how long she should let these naive conceptions linger.

"The kids are holding on to and putting together pieces of what they know of the world. But the *time* we are taking to explore what kids think is much longer than if I told them the facts." If she told her students that hats didn't make heat, she knew that most would parrot her statement just to please her. Lacking the evidence to prove that fact, however, they would continue to prefer their own conceptions of their teacher's answer.

Surprises await the teacher who expects children to give up their conceptions at the first sign of a discrepancy. Stubbornness, a trait not limited to children, causes students to grasp at straws, O'Brien found. When the temperature inside a sweater rose even one degree, the students cheered and shouted, "Finally!" And if, as was more often the case, the thermometer stayed at room temperature, well, then, perhaps the thermometer was broken. Or perhaps the cold air got in somehow. Or maybe they just hadn't let the sweaters sit long enough. Christian wanted to seal a hat and thermometer in a metal box and leave it for a year. *Then* the temperature would be sure to rise.

Should she tell them the difference between holding heat and emitting heat, O'Brien wondered. Should she devise her own experiment on insulation? She decided to let the conceptions linger through one more round of testing. And so the sweaters, hats, and even a down sleeping bag brought from home were sealed, plugged, and left to endure the cold.

THE SLEEP OF REASON

While we often assume that reason is the guiding light of science, the history of scientific thought shows otherwise. When confronted with contradictory evidence, scientists are sometimes as puzzled as children. Through further testing, they seek additional evidence. If the results continue to disprove what they once thought, scientists often behave very much like children: they argue among themselves, they cling to their old theories, and they devise experiments that will reinforce the traditional way of thinking. As Thomas Kuhn showed in *The Structure of Scientific Revolutions*,[4] scientists are capable of holding contradictory theories about scientific concepts. Scientific communities, such as O'Brien's classroom, can take this a step further by dividing into camps that simultaneously believe several different explanations of the same event, often for many years' duration. When it comes to confronting the errors in one's thinking, scientists of all ages seem equally susceptible to certain barriers.

In theory, at least, when confronted with evidence that contradicts existing assumptions, rational observers will accommodate their thinking to fit the latest observations. A theory, says the philosopher of science Irme Lakatos, is judged on how well it solves problems.[5] If a theory generates problems that it can't solve or explain, Lakatos says, it is rejected in favor of a new theory that solves those problems and offers promise of further investigation. Even fourth-graders seek answers that can be explained by their theories. But the substitution of one theory for another is not as easy as erasing the chalkboard. Certain preconditions for conceptual change must exist if the barriers in the path to understanding are to be overcome.

We suggest several barriers to conceptual change, barriers strong enough to laugh in the face of discrepant events. Among schoolchildren the strongest of these obstacles is likely to be stubbornness, the refusal to admit that one's theory might be wrong. Children who are not often asked their opinions are especially reluctant to admit the errors in their thinking and will find ways to adjust old ideas before assimilating new ones.

Lakatos cites the varying strengths of scientific concepts as reasons why some beliefs are changed and others are not. "Hard-core ideas" take precedence over "protective-belt ideas," Lakatos posits. In the face of discrepant evidence, believers will change their "protective-belt ideas" in order to protect their hard-core beliefs, much as astronomers devised endless variations on cosmological theories, adding epicycles, altering distances, and so on just to keep the earth at the center of their cosmos. Katie was willing to believe that "hot and cold are sometimes strange," surrendering her belief in the consistency of temperature in order to build walls around the idea of "warm clothes." When children are unable to call on scientific knowledge to explain a piece of contradictory evidence, they will often call the discrepant event "magic." As many teachers know, tenacity in children makes scientists look downright flexible.

Another barrier to conceptual change is language. A teacher seeking conceptual change should be cautious about vocabulary. The difficulty of mastering new terms in addition to a new way of thinking about a concept can cause children to cling even more tenaciously to their old beliefs. Even the vernacular usage of nonscientific terms, such as "warm clothes," can cause confusion. There must be a reason why everyone calls them "warm," O'Brien's students conjectured.

Perception itself can block conceptual change as well. We tell children that "seeing is believing," but in science that often isn't true. Touch is an even more deceptive sense. Though O'Brien's thermometers had stayed at room temperature, each night the children kept warm beneath their blankets, just as each winter they had put on warm hats and sweaters and actually *felt* the warmth that the thermometers refused to register. A few days of surprising results in the classroom are not likely to change such deeply "felt" thinking. Teachers and students learn firsthand the inadequacy of empiricism as a theory of knowledge. As Eleanor Duckworth so aptly put it, "The critical experiments themselves cannot impose their own meanings. One has to have done a major part of the work already, one has to have developed a network of ideas in which to imbed the experiments."[6]

O'Brien and some of her abler students could have imposed their findings on the class, saying, "Look at the thermometer. Room temperature! *Now* do you believe that sweaters don't make heat?" Textbooks attempt to do just this, presenting events and critical experiments from the history of science up to the present day. But, to paraphrase Louis Pasteur, understanding favors the prepared mind. If the learner has done a major part of the work already and has developed Duckworth's "network of ideas in which to imbed" the new idea, an enlightened view is more likely to evolve. If not, the experience may mean nothing.

While children and adults face many of the same barriers to learning, a few of the obstacles to conceptual change are developmental. Children in the middle elementary grades are only beginning to use concrete operations. As Piaget's research showed, when confronted with new evidence, children in these grades tend to revert to the earlier stage – in this case the preoperational stage, characterized by an inability to conserve concrete properties, such as size and weight, and by difficulties in measurement and logical reasoning.

Children at this stage of development swear by their feelings in the face of the evidence and, having limited experience with the scientific method, trust their lifelong convictions more than they trust a thermometer. They are particularly susceptible to what researcher Judith Tschirigi calls "sensible reasoning."[7] Such reasoning, Tschirigi says, often takes precedence over Piaget's "concrete reasoning." Children will modify their experiments to accommodate their beliefs long before they will change their beliefs to fit the evidence.

Because children's minds are still "under construction," they must be treated with care where conceptual change is concerned. As O'Brien learned, expecting students to exhibit conceptual change after having observed a few discrepant events is bound to be frustrating for both teacher and students. A teacher who chooses to let students tackle their own misconceptions is well advised to consider Lev Vygotsky's "zone of proximal development,"[8] also known as a child's "construction zone." Such developmental factors as memory, skill acquisition, and reasoning ability affect a child's capacity to incorporate new knowledge into existing schemes of thought, Vygotsky said.

The "construction zone" encompasses what a child is developmentally ready to consider. Any new information or skills needed for conceptual change may lie outside the zone if the child is developmentally unprepared to learn them. O'Brien's students who cheered when the temperature inside the "warm" clothes rose a single degree evinced such unpreparedness. They failed to recognize that the single degree was an insignificant rise and may even have resulted from a misreading of the thermometer. Conceptual change can take place only within the

"Omigosh! My science project is gone!"

> There are no prefabricated units to be assembled in mental constructions, though many science texts would seem to suggest otherwise.

"construction zone." Since children's scientific skills are constructed more slowly than many buildings, conceptual change in science will not happen overnight. Unfortunately for teachers, there are no prefabricated units to be assembled in mental constructions, though many science texts would seem to suggest otherwise.

Finally, science itself has "critical barriers" to understanding, which present difficult hurdles to children and adults alike, according to David Hawkins.[9] Along with the seemingly innate problems involved in understanding size, volume, weight, and elementary mechanics, Hawkins identifies the concept of heat as containing some of these critical barriers. The perception of things as "hot" and "cold" conflicts with the scientist's conception of heat as a measurable quantity contained by all objects, Hawkins says. Since scientists held misconceptions about heat for hundreds of years, Hawkins reminds us, understanding heat is a hurdle that will not be cleared by students in a single two-week unit.

FIGHTING THE GOOD FIGHT

With so many obstacles standing in the way, conceptual change in science might seem not merely difficult to achieve, but impossible, especially based on a few measly discrepant events. Yet certain teaching strategies have been devised that can help teachers overcome these obstacles.

When discrepancies between children's thinking and the evidence are laid on the table, the teacher assumes a crucial role. Far from being a passive observer, the teacher can actively promote new thinking patterns through a variety of methods.

1. *Stressing relevance.* Because children so frequently assume new information to be "stuff we learned in school," the teacher must connect new concepts to the child's everyday life. In the case of heat, O'Brien asked her students about times when they had felt heat coming from an object. She asked them if they could think of anything that trapped heat, that kept things warm without heating them. She asked them to think about animals that have "warm coats" and to consider whether those coats make heat. She asked them whether a handful of fur would stay warm if removed from the animal. Unless children appreciate the relevance of their experiments to their everyday life, they may just brush off a discrepant event as "some weird thing we saw in science."

2. *Making predictions.* Children who are asked to predict the results of their experiments are more willing to change their thinking than are children who function as passive observers. This neglected aspect of elementary science instruction is essential because it asks students to link their new knowledge with what they already know in order to form hypotheses. Through ample writing in journals, O'Brien's students predicted temperatures and gave reasons for their predictions. Even though they were often wrong, they had the chance to incorporate yesterday's thinking into today's task. The use of journals in O'Brien's class also facilitated what Piaget called "reflective abstraction"[10] – the chance to reflect on one's thinking, without which development does not occur.

3. *Stressing consistency.* Although nearly everyone lives quite comfortably while embracing a wealth of ideological and political contradictions, a teacher should encourage children facing new patterns of thought to be consistent in their thinking. A child can state categorically that the thickness of a sleeping bag "causes the heat inside" and that pressure "causes the heat inside" a rolled-up rug. Yet that same child can maintain that hats, which are neither thick nor compressed, will be hot for no reason at all.

The teacher should tactfully draw attention to the inconsistencies in children's thinking and ask them to consider how two contradictory statements could both be true. While some children will blithely ignore the illogic of contradictions, many will confront inconsistencies and change their thinking as a result. The development of logical, consistent thought is thus a by-product of teaching aimed at conceptual change, and developing an orderly view of the world can prevent the compartmentalization of knowledge that occurs when students think that nature works one way at home and another way at school. Katie reflected such inconsistency when she wrote that "hot and cold are sometimes weird." If she is encouraged to seek consistency, however, she will not be satisfied until she has seen some order in the world around her.

If one concept is to replace another, then certain conditions must prevail.[11] First, the old way of thinking must be challenged by direct observation, by a discrepant event. Next, a new explanation for the phenomenon in question must arise, an explanation that is understandable (take care with vocabulary) and plausible. Finally, the new explanation must lead to further testing. If these conditions can be created in the classroom, conceptual change can occur.

BRINGING IT ALL BACK HOME

Overcoming resistance to conceptual change in children is clearly an ongoing struggle. Children will not easily surrender their carefully constructed schemes of thought to the onslaught of new evidence, no matter how convincing it seems. Dedicated teachers using a variety of strategies, including infinite patience and the willingness to let children swim upstream toward an elusive understanding, can help their students overcome these barriers. But reluctance to change one's way of thinking is not limited to scientists and students.

Despite massive evidence suggesting that students learn by doing, by manipulating, by experimenting, the great bulk of science teaching is still based on textbooks. Some independent teachers have pursued conceptual change in their science classes, but doing so presents a number of monumental questions to curriculum builders, school administrators, textbook authors, and anyone whose job description includes monitoring the "coverage" of curriculum in any subject area.

- Is mere "coverage" of curriculum material a viable or reasonable goal?
- What is "growth" in science, and how will we assess it?
- What content should teachers know in order to be able to recognize and then challenge children's naive conceptions?

- How can teachers adapt texts and curriculum to meet the constructivists' challenge about how children learn?
- Are there appropriate grade levels for various science topics, and what content areas are appropriate at which levels?

Any teacher who has really tested his or her effectiveness by checking students' understanding of concepts faces a startling dilemma. Teaching science in a constructivist mode is slower and involves discussion, debate, and the re-creation of ideas. Rather than following previously set steps, the curriculum in a constructivist classroom evolves, depends heavily on materials, and is determined by the children's questions. Less "stuff" will be covered, fewer "facts" will be remembered for the test, and progress will sometimes be exceedingly slow. It is definitely a process of *uncovering* rather than covering.

The alternative is to cover the prescribed material, knowing full well that the students may be masking their lack of conceptual growth by solving the *teacher* rather than learning the *content*. In order to survive, students learn to give teachers what they want, whether memorizing and regurgitating book definitions of terms, completing lab reports in a certain format, or filling in the correct blanks on an exam.

Successful students have always done these things, and we suspect that they always will. It is their path to survival in schools. Nevertheless, their doing so presents teachers with an age-old dilemma: Do we cover the material, knowing full well that what we cover will be understood superficially at best – accommodated, but not assimilated? Or do we forget about coverage and work to help children test their untutored conceptions against the real world through challenging questions, predictions, and experiments, knowing that we will be sacrificing breadth for the sake of depth? We suspect that these questions will be central in the coming decade. Moreover, further study is needed to find out more about the social aspects of learning, about how students use their conceptual understandings outside the classroom, and about how their experience grows into scientific models that they find satisfactory.

One thing is certain. We need to study more deeply the views held by children, to learn the purposes they serve, to learn their innate structures, and to learn how they are formed and used. Perhaps then we will be better able to understand our role as teachers.

PUTTING STUDENTS IN THE HOT SEAT

For the third day in a row in O'Brien's classroom, the children rushed to their experiments as soon as they arrived. The sweater, the sleeping bag, and the hat were unwrapped. Once again the thermometers uniformly read room temperature. O'Brien led the disappointed children to their journals. But after a few moments of discussion, she realized that her students had reached an impasse. Their old theory was clearly on the ropes, but they had no new theory with which to replace it. She decided to offer them a choice of two possible statements.

"Choose statement A or statement B," she told them. The first stated that heat could come from almost anything, hats and sweaters included. In measuring such heat, statement A proclaimed, we are sometimes fooled because we're really measuring cold air that gets inside. This, of course, was what most children *had* believed at the outset. Statement B, of O'Brien's own devising, posed the alternative that heat comes mostly from the sun and our bodies and is trapped inside winter clothes that keep our body heat in and keep the cold air out.

"Write down what you believe," O'Brien told the class. "Then stand in this corner if you believe A and in that corner if you believe B. If you're not sure, stand here in front."

Pencils went to lips, and eyes studied the ceiling. Finally, after much thought, the statements were recorded in the journals. Students approached the chalkboard, ready to turn right or left. Katie turned left toward the B corner. Owen stood in the center for a moment, then followed Katie. Neil turned right and clung to his "hot hat" theory. Christian stood in the middle. One by one, the students took a stand. And when the cold gusts of approaching recess blasted through the classroom, O'Brien counted noses. A few children had joined Neil. Stubborn, perhaps, but O'Brien had to admire the strength of their convictions. Christian and one other child stood undecided in the center, while the rest of the class stood proudly with Katie and Owen, convinced by their own testing that "warm clothes" aren't really warm and that the heat that seems to come from them actually comes from the warm bodies they envelop.

"How can we test this new theory?" O'Brien asked. Immediately Neil said, "Put the thermometers in our hats when we're wearing them." And so the children went out to recess that day with an experiment under their hats.

As Deb O'Brien relaxed during recess, she asked herself about the past three days. Had the children really changed their minds? Or had they simply been following the leader? Could they really change their ideas in the course of a few class periods? Would any of their activities help them pass the standardized science test coming up in May? O'Brien wasn't sure she could answer any of these questions affirmatively. But she had seen the faces of young scientists as they ran to their experiments, wrote about their findings, spoke out, thought, asked questions – and that was enough for now.

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John A. Zahorik

Encouraging—and Challenging—Students' Understandings *

In productive constructivism, the teacher's job is to fuse students' knowledge with what experts know, not to favor one over the other.

The notion that people don't simply discover knowledge but make or construct it has strong appeal. So, too, do the related ideas that knowledge results from disequilibrium, emerges from prior knowledge, and grows through exposure and feedback. For these reasons, constructivism is a growing trend; it is beginning to appear in the teaching of literacy, mathematics, science, and other areas. Yet because constructivism often clashes with more traditional practices, introducing it in a school is no easy matter.

Over the past several years, I have been working with teachers as they move toward constructivism. I have found that they encounter several problems. The most formidable is the tension between students' constructions—what students learn from group problem solving, laboratory experiments, and so forth—and the constructions of experts in that field.

Some teachers choose to emphasize students' understandings at the expense of experts' constructions, while others do the opposite, minimizing the importance of what the students learn. Both groups are making a mistake; the teacher's job is to help the students integrate the two.

A teacher does not promote understanding by permitting students' constructions to stand even though they clash with experts' constructions.

Experiencing and Revising

As constructivism itself posits, knowledge is not a static phenomenon; it changes as we engage in new experiences that test what we know. These new experiences may cause us to alter or add to our understanding, sometimes in subtle ways and sometimes dramatically. Or the experiences may affirm our understanding until another new experience again causes us to rethink our ideas.

All of us are constantly engaged in this process in our everyday lives, but this is also the process that scholars in every discipline follow. They seek new experiences to test, and they subsequently construct knowledge through inquiry and scholarly dialogue. The results are the revised understanding of the origin of stars, the cause of ulcers, and the reason dinosaurs became extinct.

This is not to say that knowledge of nonexperts is unimportant. It is very important, because in disciplines ranging from history to science to math, the only thing we can know is our own understanding of the knowledge—our own construction of it. (In this sense, all of our constructions are, probably, misconceptions. If they appear to be true, it is only at a particular time and in a particular place.)

This brings us back to the problem teachers encounter. Here is a closer look at the two solutions some teachers adhere to, followed by other—more constructive—approaches to constructivism.

Erring on the Side of Students

Teachers who err on the side of students' constructions often engage students in group activities calling for problem solving, decision making, and invention. The students, either individually or in groups, develop their own understandings, which they then present to the class. The teacher considers these personal constructions as satisfying to the students and adequate for their purpose, knowing that as the students have new experiences, they will continue to develop these concepts.

An example of this type of constructivist teaching is the 4th grade teacher who taught a lesson on insects. She divided her class into groups of four or five and gave each group a box containing models of various insects. She announced that each group would do what scientists do: classify the bugs based on common characteristics—size, color, shape, type of wings and antennas. The groups then presented their schemes to the entire class. The teacher asked the students to discuss the various approaches and demonstrate the efficacy of their own categories. But the lesson ended

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* *Zahorik, John A. (1997) Encouraging and Challenging Students' Understandings.* **Educational Leadership.** 54, March (6): 30-32. *Reprinted with permission of the Association for Supervision and Curriculum Development. Copyright 1997 by ASCD. All Rights reserved.*

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there. The teacher did not introduce the scheme of distinguishing characteristics that scientists have agreed to use in classifying insects.

Erring on the Side of Scholars

Teachers who err on the side of constructions from the various disciplines also may begin the lesson with group activities calling for problem solving and related processes. These activities, however, function more as an introduction to and motivation for the major part of the lesson. The teacher gives the groups only a short time to investigate a problem or perform a task and then report back to the class.

After listening to the reports—often with little discussion—the teacher presents knowledge from the disciplines, viewing it as constructed knowledge rather than as a discovered, stable reality. The message, however, is clear: Students' constructions are trivial and often wrong, and experts' constructions must be accepted. The teacher usually does not discuss the experts' constructions in depth, although he or she does provide examples and pose and respond to questions.

An economics lesson taught to another group of 4th graders exemplifies this approach. The teacher introduced the terms *goods, services, natural resources, labor,* and *capital* by defining and providing examples of each. She then organized a scavenger hunt of sorts. Students were to look for examples of natural resources, labor, and capital anywhere in the school, then record their discoveries on a form the teacher provided. After a 20-minute hunt, the students returned and shared their results.

The teacher identified and corrected questionable examples. She then began a lecture on the economics principles underlying the relationship of natural resources, labor, and capital to goods and services. She noted, for example, that people's choices about what goods and services to buy and consume determine how resources will be used, and that people cannot have all the goods and services they want because productive resources are limited. She did not initiate a discussion of these principles, nor did she ask the students to draw conclusions about goods and services based on the examples they had found.

Integrating the Two

If the goal of teaching is to impart conceptual understanding, neither of these constructivist strategies is entirely productive. A teacher does not promote understanding by permitting students' constructions to stand even though they clash with experts' constructions. In fact, it is dangerous to ignore the concepts, conventions, and processes that are essential to the maintenance of our culture or to wait for them to emerge over time through random experiences. As Driver and colleagues (1994, p. 6) point out, "Scientific entities and ideas, which are constructed, validated, and communicated through the cultural institutions of science, are unlikely to be discovered by individuals through their own empirical enquiry."

On the other hand, as Von Glaserfeld (1995, p. 5) reminds us, "Concepts cannot simply be transferred from teacher to students—they must be conceived." Students' experiences influence their perception and processing of

Problem-solving tasks are critical to the growth of student constructions.

new information.

Vygotsky (1986) stresses that both of these types of constructions are essential to understanding. He contends that students' constructions, or what he calls *spontaneous concepts*, and experts' constructions, or what he calls *scientific concepts*, develop in reverse directions. A spontaneous concept works its way up until it reaches a level that permits a person to absorb a scientific concept. Scientific concepts work their way down, supplying logic and structures to spontaneous concepts.

Activities in which students engage in problem-solving tasks—as individuals or in small groups—are critical to the growth of student constructions. These activities can also be useful as a way to present experts' knowledge in an indirect way.

What is essential for bringing the two types of constructions together, however, is teacher-student dialogue. As Leinhardt (1992, p. 24) says, when we use the classroom "as a social arena for the public examination of ideas . . . students naturally build on or refute old ideas as they are merged with new knowledge."

In Tobin and Tippins's (1993, p. 11) view, group interaction can "provide a milieu in which students can negotiate differences of opinion and seek consensus." Teachers must examine, discuss, critique, and challenge students' constructions in relation to those of both experts and other students. Conversely, teachers need to critique and discuss experts' constructions in relation to emerging student constructions.

Reconstructing the Lessons

Suppose we apply these recommendations to our two examples. In the lesson on insect characteristics, after the students share their classification schemes, the teacher introduces the experts' approaches to insect identification. She can do this directly or through a discovery activity.

The object is not to conclude the activity with the correct answer, but to extend the discussion. By comparing and contrasting their constructions with the experts' constructions, the students gain insights into both and begin to reconceptualize their constructions in the direction of those of the experts. If the students' original conceptions were viable but different from the expert opinions, they at least become aware that there is an agreed-upon classification scheme that scientists use as a standard convention in studying insects.

In the lesson on economics, the teacher asks her students to critique the economic principles that she has presented. She and other students may then critique the critiques (that is, the constructions), examining them for inadequacies and errors. This type of critical dialogue about knowledge in various disciplines is what Perkinson (1993) has labeled *critical teaching*.

Nurturing the Process

Some teachers may view the constructions of students and experts as irreconcilable. But, again, in a school setting, the teacher must fuse the two if conceptual understanding is to occur.

To some degree, students' and experts' constructions are already joined, no matter how the teacher organizes his or her lessons. Constructing knowledge is a constant, naturally occurring process as students view new information—such as experts' constructions—in terms of their prior knowledge. Teachers can nurture this process. They can help students negotiate meaning through discussions that bring the understandings of both of these groups together. ■

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STRATEGIC TEACHING IN SCIENCE*

Charles W. Anderson

This chapter discusses cognitive instruction in science; that is, teaching science in a way that helps students monitor and improve their thinking about the natural world. Much of this chapter is based on a program of research and development in which I and a number of colleagues (especially Edward L. Smith and Kathleen J. Roth) have been engaged for the last seven years. In this program, we have studied science teaching and learning at the elementary school, middle school, and college levels, and we have developed and implemented new approaches to teaching science at each level.

Our program is but a small part of a substantial research tradition involving researchers in many countries who have studied the teaching and learning of science from a cognitive perspective. This research tradition has produced books such as those by Driver, Guesne, and Tiberghien (1985) and by West and Pines (1985), as well as a variety of review articles such as those by Anderson and Smith (1987) and by Carey (1986).

In writing this chapter I was asked to address three questions:

1. To what extent is the framework for strategic teaching and learning that was developed in the first half of this book consistent with research in science?

2. To what extent is this framework helpful for planning sequences of instruction in my content area?

3. What adaptations, if any, need to be made to teach low- and high-achieving students so that all students will benefit from strategic teaching and cognitive instruction?

The chapter ends with direct answers to these questions. My answers are based on my understanding of the problems science teachers encounter in planning and in the classroom. Therefore the chapter begins with a discussion of those problems and of some of the solutions that we and others have developed. This discussion focuses on the problems encountered by a hypothetical teacher whom I shall call Ms. Lane. She is a fifth-grade teacher who is preparing to teach a unit on light and vision. Although she

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*Anderson, Charles W. (1987). Strategic Teaching in Science. **Strategic Teaching and Learning: Cognitive Instruction in the Content Areas.** Oak Brook, IL: North Central Regional Educational Laboratory. Reprinted with permission of North Central Regional Educational Laboratory. Copyright 1987 by NCREL. All rights reserved.

is not familiar with the term "strategic learning," she shares many of its goals. In particular, she is concerned about her students' ***understanding*** of the content she teaches. She remembers science courses that she survived by memorizing for tests, then soon forgetting what she had memorized. Too often, she sees her students starting to do the same thing; they seem to come out of science lessons with memorized trivia rather than true understanding, and this is a matter of great concern to her.

Ms. Lane is dissatisfied when she sees her students memorizing rather than understanding, but what can she do to help them? This clearly is not an easy task; if it were, there would be a lot less memorizing in school science classes. In order to teach for understanding, Ms. Lane must develop solutions to a number of difficult problems. The following sections focus on four of those problems:

1. A definitional problem: What does it mean to "teach for understanding" in science?
2. A curricular problem: What is it about science that is worth understanding
3. A student learning problem: How does scientific understanding develop in students?
4. An instructional problem: What can teachers do to help students understand?

The Definitional Problem: Teaching for Understanding

Teaching for understanding is, of course, what this book is all about. Strategic teaching assumes that what teachers teach will be based in part on what they understand about how students learn. This focus on understanding is apparent in the six principles about learning with understanding that form the framework for Chapter 1 of this book. Restating these principles may aid science teachers like Ms. Lane to understand what it means to teach for understanding in science.

1. Learning is goal oriented; skilled learners are actively involved in constructing meaning and becoming independent learners.
2. Learning is linking new information to prior knowledge.
3. Learning is organizing knowledge.
4. Learning is strategic; skilled learners must develop a repertoire of effective learning strategies as well as be aware of and control their own activities.
5. Learning occurs in phases, yet is nonlinear and recursive; learners must think about what they already know, anticipate what they are to learn, assimilate new knowledge, and consolidate that knowledge.
6. Learning is influenced by development, and there are important developmental differences among learners.

Ms. Lane is not an expert on educational research. She is, however, an experienced teacher who has developed her own ideas about understanding through years of practice. She is a good teacher, and as she compares her ideas with those listed above, she finds that they are highly compatible. (Unfortunately our research indicates that this is not universally true. Hollon and Anderson (1986), for example, found that some experienced teachers, typically teachers who do not understand science very well themselves, found the ideas above threatening and incompatible with their present practice.)

Therefore, Ms. Lane sets a goal for herself. She accepts the ideas listed above as a reasonable definition of learning with understanding, and she resolves to teach in a way that helps her students show these characteristics in their own learning. Before she can achieve this goal, however, she faces important problems involving curriculum, student learning, and instruction.

The Curricular Problem: What is Worth Knowing?

At the outset of curriculum planning, Ms. Lane and other science teachers must decide what they want their students to learn. It seems reasonable to expect that textbooks are not as helpful in this respect as they should be. When Ms. Lane opens her textbook to the unit on light, she discovers that the textbook presents only a deceptive appearance of having clearly defined "content" that can be taught to students in a straightforward manner. In fact, she can interpret the textbook from a variety of different perspectives, and each perspective suggests a different definition of the curricular content of the light unit. Three perspectives that are common among teachers and science educators are contrasted below.

Teaching Science as Facts, Rules, and Definitions

When she looks at her textbook, the first thing that Ms. Lane notices is that it contains a lot of facts (light travels in straight lines; light travels very fast; the colors in the spectrum...). There are also some definitions (transparent, translucent, opaque, lens, retina...). Although this textbook does not have them, it is also common for more advanced texts to contain formulas and rules. It certainly seems reasonable, looking at a science textbook, to think of science as a long list of facts, rules, and definitions to be learned. The most reasonable interpretation of Ms. Lane's textbook is certainly that the authors intended science to be taught this way.

Writing textbooks that present lots of facts makes good business sense. This way of thinking about science is common among the teachers we have worked with in our research and development projects (Anderson and Smith in press, Hollon and Anderson 1986). Even college professors often treat science teaching essentially as the presentation of facts, rules, and definitions, albeit in a well-structured and organized manner (Anderson 1986). Thus teaching science by presenting facts, rules, and definitions represents the "path of least resistance" for both teachers and textbook publishers.

Unfortunately, it is virtually impossible to teach lists of facts in the meaningful way that we defined as cognitive instruction at the beginning of this chapter. Learning facts puts the students in a passive rather than an active role, encourages memorization rather than the active construction of knowledge, and fails to connect science content with students' prior knowledge of the world. Because of these deficiencies, attempts to teach science as facts, rules, and definitions typically produce little understanding and less retention (cf. Anderson, Sheldon, and DuBay forthcoming; Anderson and Smith in press; Clement 1982). Ms. Lane knows from experience that she needs to do more than teach her students lists of facts, rules, and definitions. There *must* be more to science than that, but what?

Teaching Science as Process Skills

One popular answer to Ms. Lane's question focuses on "science process skills." These are the skills necessary to conduct investigations of the natural world, such as observing, measuring, inferring, and so forth. When Ms. Lane looks at her textbook, she sees that in addition to facts and definitions it has "finding out" activities. Although the activities in this book are not particularly good, it would be possible to modify these experiences and use them to provide students with hands-on laboratory activities that would provide training and practice in science process skills. Would this be enough to help Ms. Lane's students learn science with understanding?

Unfortunately, the research evidence suggests that hands-on activities or instruction in process skills will not ensure meaningful learning, either alone or in combination with conventional fact-based instruction (Roth 1984, Smith and Anderson 1984). One problem is that science processes do not seem to consist of unitary skills that can be transferred from one context to another. Observing cell cultures, for example, has little in common with observing geological formations or with observing chemical reactions. Furthermore, a major component of process skills seems to be content knowledge (e.g., a good observer of cell cultures must know a lot about cells).

So science is more that the sum of process skills plus facts, rules, and definitions. Ms. Lane must find a different way of thinking about the content that she teaches before she can truly engage in cognitive instruction in science.

Teaching Science as Explanation

There is another approach to defining the content of science, one that has much more potential for serving as the basis for cognitive instruction in science. This approach emphasizes the explanatory functions of science. Science is our best attempt to explain *how* and *why* events happen as they do in the natural world. How does light help us to see, for example? How do we see colors? Why do plants need light to grow? Why is the sky blue?

If Ms. Lane looks hard, she can find passages in her textbook in which scientific principles are used to explain natural phenomena. Here, for instance, is a passage explaining how light helps us to see:

> Like a rubber ball, light bounces off most things it hits. When light travels to something opaque, all the light does not stop. Some of this light bounces off. When light travels to something translucent or transparent, all the light does not pass through. Some of this light bounces off. When light bounces off things and travels to your eyes, you are able to see (Blecha, Gega, and Green 1979, p. 154).

Is this a "main point" of the unit on light? There is certainly no indication that the authors of the text thought of it that way. The passage quoted above is buried in the middle of a chapter; no special markers indicate its importance. Our research, though, has convinced us that Ms. Lane and other science teachers can truly teach for understanding only if they "reconstruct" the contents of science texts, putting much more emphasis than most texts do on using scientific theories and principles to explain phenomena in the natural world.

There are a number of advantages to focusing on science as explanation. This approach gives back to scientific theories their original purpose, a purpose that all too often is lost in science as it is taught in schools. Scientists develop their theories because they have *questions* about how and why the world works. All too often, we teach students the answers (or procedures for getting answers) without letting them know what the questions are. Recent work in the history and philosophy of science has emphasized that science is fundamentally an attempt to describe and explain the natural world. Scientific progress involves constructing more powerful descriptions and explorations, not simply discovering more facts and laws according to the "scientific method" (cf. Kuhn 1970, Mayr 1982, Toulmin 1961).

So Ms. Lane decides that she will emphasize the explanatory functions of science in her treatment of the light unit. She will ask questions calling for explanations and help her students use passages from the text like the one above to construct scientific answers to those questions. In making this decision, Ms. Lane has taken an important step toward cognitive instruction in science. She has decided to involve her students in a central activity of science, one that requires them to actively construct meaning and to organize and use their personal and scientific knowledge. She has also taken a key step toward linking the information in the light unit to her students' prior knowledge. This linkage is examined in detail in the next section.

The Student Learning Problem: How Does Scientific Understanding Develop?

Ms. Lane has now made a strategic curricular decision about her unit on light and vision: she will emphasize teaching her students to explain phenomena scientifically. As she looks through the textbook, she can now see a number of phenomena that she wants her students to explain: how we see; how light interacts with transparent, translucent, and opaque objects; how our eyes work; and so forth. She cannot mediate learning successfully, however, until she understands what her students will be going through as they try to master the key scientific principles and use them to construct explanations. There are two aspects to this understanding: (1) the nature of students' prior knowledge and how it must change, and (2) the strategies that students use for processing new information about science.

Students' Prior Knowledge and the Process of Conceptual Change

Explanations provide a link between science content and students' prior knowledge when facts do not. Students generally just do not know scientific facts before they begin a new unit, so if science is defined as consisting of facts, rules, and definitions, it often appears that students simply know nothing about the topic they are to study. A different and more complex picture emerges, however, if students are asked to explain things that they see in the world around them. It turns out that students *do* have explanations, but not the ones that scientists have developed. A look at the nature of students' explanations reveals why learning science is so complex and difficult for most students.

Consider, for example, the explanation quoted above from Ms. Lane's textbook about how light helps us to see objects. What do students say if they are asked how light helps us to see things? We asked this question to large numbers of fifth graders (Anderson and Smith 1987; Eaton, Anderson, and Smith 1984), and the following are typical answers:

> "In the dark, you can't see anything, so it makes things so you can see them."

> "It brightens the path to the object we are looking at."
>
> "It lights up the object so you can see it."

These student explanations certainly are not untrue or unreasonable, but they do not seem entirely satisfactory, either. What is missing (aside from some fancy vocabulary) in these explanations that is present in the textbook explanation quoted above? You might want to take a minute to compare the text and student explanations for yourself before reading on.

* * * *

There are actually several problems with the student explanations. The first one, for instance, is not really an explanation at all; it restates the question in different words. Perhaps the most important thing to notice about these explanations—a characteristic that shows up over and over whenever students discuss vision—is that they *do not mention reflected light*. In our investigations of students' ideas about how we see, we have found that only about 5 percent of the fifth graders we studied were aware that reflected light played a role in vision. The rest thought that light merely made things bright or visible so that we could see them directly.

Our investigations of students' conceptions of light and vision revealed that students' explanations of common phenomena differed from scientific explanations in many other ways as well. Students generally believed that their eyes worked by seeing objects rather than by detecting light, for example. Many students were not sure whether light was always in motion or not. Most students thought that white light was clear or colorless, rather than a combination of the colors of the spectrum. We discovered that students had an interconnected network of mutually supporting beliefs about light and vision that made sense to them, but that were incompatible with scientific ideas presented in the textbook.

The books and review articles cited at the beginning of this chapter describe similar student beliefs about dozens of other scientific topics. These student beliefs are incompatible with scientific theories; for this reason we label them *misconceptions*. They are not, however, foolish or completely wrong. They are often compatible with our normal language. (For example, we generally say, "I look out the window and see the tree," rather than, "I see the light reflected by the tree coming in the window to my eyes.") Misconceptions are generally ideas that are reasonable and appropriate in a limited context, but students inappropriately apply them to situations where they do not work.

A strategic teacher in science must understand the dual nature of students' prior scientific knowledge. In part, prior knowledge is the foundation for meaningful learning in science. Students must relate scientific theories to their own ideas about the world in order to see science as a means of understanding the world rather than a collection of arcane and disconnected facts. On the other hand, students' misconceptions are barriers to successful learning. They must give up or modify many of their beliefs about the world in order to truly understand science.

Thus, science learning is a complex process of *conceptual change*, in which students must modify some of their beliefs about how the world works while strengthening and reorganizing others. In this way, successful learners of science gradually reconstruct their understanding of the natural world. The interconnected and mutually supporting nature of student misconceptions makes this process an arduous one for most students.

Students' Science Learning Strategies

Ms. Lane thinks about the process of conceptual change, and it helps her understand why she was so concerned about her students' learning. They were not really going through the process of conceptual change. They were just memorizing a few facts without altering their misconceptions at all! Still, she is puzzled. She can find many passages in the book like the one about vision quoted earlier. How could the students *read* those passages without seeing the conflict?

My colleague Kathleen Roth has conducted a study that helps to answer Ms. Lane's question (Roth 1985). She conducted careful analyses of students' thinking as they read science textbooks. The students in her study were middle school students reading chapters from one of three texts, two commercial and one experimental, about photosynthesis, the process by which plants use sunlight to make their own food.

In order to truly understand these textbooks, the students in Roth's study had to go through a process of conceptual change. All the students in the study began with a number of important misconceptions, including the belief that plants get their food from the soil rather than making it themselves. She found, however, that most students did not change their basic ideas about food for plants. Instead, they relied on reading strategies that enabled them to cope with the normal demands of school through superficial learning rather than true conceptual change. Roth described at least five different strategies or approaches to reading science textbooks, only one of which resulted in conceptual change. Those five strategies are described below (from Roth 1985).

1. Overreliance on prior knowledge in order to complete a school task. Students using this strategy were generally below-grade-level readers who interpreted the text almost completely in terms of their prior knowledge and incorrect beliefs about plants and food. When asked to recall what the text said, for example, they frequently attributed to the text things that were not in the text but came from their prior knowledge. Although they reported the text made sense to them, these students appeared to avoid thinking about the text itself as much as possible. If they could decode the words and get enough of the gist of the text to call up some appropriate prior knowledge, they reported that the text "made sense."

For example, Maria read a section of the *Concepts in Science* (Brandwein et al. 1980) text that used milk as an example of how all food can ultimately be traced back to green plants, the food producers. Maria announced that "most of this stuff I already knew," and that this was the easiest section to understand. "It was about milk." When probed, she expanded her summary of the text: "It's just about milk...how we get our milk from cows." She never picked up any notion that plants make food. This is typical of her pattern of reading to find similar ideas, ignoring the rest of the text and relying on prior knowledge to fill in the details.

The students using this strategy answered questions posed in the text by thinking about their real-world knowledge about plants rather than using text knowledge. Without thinking about plants' roles in producing food, for example, Maria came up with the right answer to the following question by thinking about her prior knowledge:

> Question: All the food we eat can be traced finally back to the
>
> (a) green plants
>
> (b) cows

Maria correctly picked (a) and explained: "I don't know...I just circled green plants because everybody eats...not everybody eats cows but *everybody* eats green plants."

Thus strategy 1 enabled students to complete assigned tasks and comply with school expectations without really engaging the text at all.

2. Overreliance on words in the text in order to complete a school task. Another group of students, also generally poor readers, isolated words without relating those words to each other or to any prior real-world knowledge. In recalling what they had read, these students identified words or phrases ("It was about chlor-something and an ecosystem") without giving any description or meaning to them. In spite of this lack of attention to meaning, these students reported that they "understood" the text if they were able to decode the words and to identify details in the text that satisfactorily answered questions posed by the text. They reported feeling confused only when they encountered unfamiliar words that they could not decode. For example, when asked whether there were any places in the *Modern Science* text (Smith, Blecha, and Pless 1974) that were confusing, Tracey reported that it was just "some of the words I didn't get." On day three, she pointed out the following *words* as places where she was confused: fermentation, chlorophyll, chloroplast, cotyledon, embryo, dormant.

In answering text-posed questions, students using this strategy simply looked for a "big" word in the question, located that word in the text, and copied the word along with words surrounding it in the text. These copied words may or may not have sensibly answered the question, but the students were satisfied just to have an answer. Frequently, this strategy produced answers that would be acceptable to most teachers. When students were asked interview questions about real-world plants, students relied totally on their experience and prior knowledge. They saw no relationship between the text and the plants. Thus, Tracey recalled the book being about "chlorophyll" and "photosynthesis," but these words were never mentioned when she was asked how a particular plant gets its food.

The students' use of the text was driven by their school knowledge of what was needed to finish the work. They had found that being able to recite key words and phrases from the text (especially large vocabulary words) can often get you by. Real-world knowledge was for them a completely separate realm of knowledge used to explain everyday, nontext phenomena.

3. Overreliance on unrelated facts in the text due to an "addition" notion of learning. This strategy was used by better readers who tried to learn from the text instead of just trying to finish the assigned work. These students held the view that school science learning is all about developing lists of facts about natural phenomena. Their prior experience with schooling had convinced them that memorization of unrelated facts is satisfactory learning. They rarely attempted to relate the facts from the text to each other or to their real-world knowledge about plants.

Students using this strategy often had fairly accurate and complete recall of explicit text material. However, they remembered ideas in no particular conceptual order, they placed equal emphasis on trivial details and on main concepts, and they did not link facts together to develop an overall picture of the main concepts. For example, Myra remembered a lot of details about an experiment that had been described in the *Concepts in Science* text:

> She had some fish and she had some plants in there and one day she was looking at them and a bubble came out of one of the plants. And she started experimenting a little, and she noticed they were giving off oxygen...They asked us what we think about what is she trying—is it oxygen, they asked us what we thought. I put one time it did and one time it didn't...They said the first time it wasn't sunny all the time. The first time it was out for one week and every day it was sunny.

However, when the interviewer asked Myra whether the girl doing the experiment had made a conclusion about the role of the sun, Myra said simply, "no." Although she remembered a lot of details, she missed the critical reason for including the experiment in the text.

Like students using the first two strategies, students using this strategy answered questions about real plants without making reference to any of the facts they had read about in the text and included in their recall. Since they separated school science from plants in the real world, they could not use the information in the text to change their misconceptions about food for plants. Thus the text failed to help them through the process of conceptual change.

4. Overreliance on prior knowledge in order to make sense of disciplinary/text knowledge. This strategy was used by a relatively large number of students, most of whom were reading at or above grade level as measured by standardized achievement tests. These students did not focus primarily on developing strategies to get by in school. Instead, they seemed to be genuinely trying to make sense of the text and the disciplinary knowledge it contained. Thus, in contrast with the first three strategies, this is a sophisticated strategy in which readers attempted to link prior knowledge and text knowledge. These students generally expected the text to *confirm* their prior knowledge, however, so that their goal in reading the text was basically to verify and add details to what they already knew. This attitude was expressed by some as, "Basically, I already knew all this."

Because the students' prior knowledge was so strongly held and because it was often in conflict with the text content, the students using this strategy had to distort or ignore some of the text information to make it fit. Thus, these students *did* integrate prior knowledge and disciplinary knowledge. However, with prior knowledge taking the driver's seat in the process, learning was often quite different from what was intended by the authors of the text.

5. Conceptual change strategy. Some students in Roth's study, all but one of whom were reading the experimental text, used a conceptual change reading strategy. These students also worked to reconcile text information with their prior knowledge, but they allowed the text to take the driver's seat in their attempts to integrate real-world knowledge and text knowledge. Thus, they used text knowledge to *change* their ideas about food for real plants. These students recognized the conflicts between what the text was saying and their own naive theories, and this conflict was resolved by abandoning or changing their misconceptions in favor of the more powerful, sensible disciplinary explanation.

All of the students using this strategy displayed abilities as they read the texts that were not observed among the other students, including the following:

> (a) They could recognize and state the main concepts of the text.
>
> (b) They were aware of the *conflict* between text explanations and their misconceptions and willing to abandon misconceptions to resolve the conflict.
>
> (c) They were aware that the text was leading to changes in their own thinking about real-world knowledge.
>
> (d) They were aware of places where the text explanations were confusing because they were in conflict with their previous beliefs.
>
> (e) They could use text ideas to answer questions about real plants.

The students using the conceptual change strategy found it to be hard work; they were the *most* likely to acknowledge feeling confused or having difficulty understanding the text. All of the other strategies left the students feeling confident that they had "understood" because they never really recognized the differences between the text's view of how plants get their food and their own naive views. All of the reading strategies "worked" in the sense that they helped students get through school tasks, but only the conceptual change strategy truly leads to learning with understanding.

Implications of Research on Student Learning

As Ms. Lane looks at her text she begins to see why most of her students do not understand it very well. The text does contain some useful explanations, but it does not really challenge students to think about or change their own explanations. It uses boldface type to emphasize new words, not important ideas. The "main ideas" listed for each chapter are generally facts. The questions in the book and unit test can be answered from students' prior knowledge or through factual recall. No wonder students generally use ineffective strategies when they read science texts!

Ms. Lane, though, does not just want to explain her students' difficulties. She wants to help them understand science. What can she do? It would be nice if she could get a better text. (In Roth's study, the conceptual change reading strategy was used by six of the seven students reading the experimental text, but by only one of the 12 students using the two commercial texts, a seventh grader reading at the twelfth-grade level.)

Like most teachers, however, Ms. Lane is stuck with the text she has. What can she do in her classroom to make cognitive instruction a reality? How can she, as a teacher, help her students engage in conceptual change learning? These are instructional questions, and they are addressed in the next section.

The Instructional Problem: Helping Students Understand

This section summarizes research findings about some of the key elements of a teaching strategy that leads to conceptual change in students. The research on which this section is based includes work by Minstrell (1984) and Nussbaum and Novick (1982) as well as our own research (e.g., Roth, Anderson, and Smith forthcoming). The research is built on comparisons between teaching that does lead to conceptual change in most students with teaching of similar materials under similar circumstances that does not. Thus, the techniques recommended here have been used successfully by classroom teachers (including Ms. Lane). This research is reviewed in Anderson and Smith (1987).

Teaching for conceptual change can be described as a three stage-process. First, there is a *preparation* phase, in which students begin to think about the phenomena that will be explained in the unit, discuss their own explanations, and become aware of the limitations of their naive explanations. Second, there is a *presentation* phase, in which teachers explain key scientific principles and theories. Finally, there is a phase of *application and integration*, in which students apply the scientific principles to new phenomena and integrate those principles and theories into their personal and scientific knowledge. These three phases are summarized in the Planning Guide for Teaching for Conceptual Change at the end of this chapter and are discussed below.

Preparation for Conceptual Change

Students generally begin learning about a topic with, at best, a vague sense that they could learn more than they now know. They generally expect that learning to consist of facts, rules, and definitions, and they generally begin with few unanswered questions about the topic. They seldom have really noticed and observed the phenomena associated with that topic. Many of Ms. Lane's students, for example, have never noticed where they have to stand to see someone else in a mirror or what a pencil looks like in a glass of water. They have never asked themselves where the colors of the rainbow come from or which direction light is traveling when they "look out" of a window. If students are to engage successfully in the active, difficult work of conceptual change learning, they need a sense of what the *potential* is for their learning, of what it is they don't know about they topic but would like to find out.

A variety of instructional techniques can help students become aware of potential learning and develop personally owned questions that will drive active inquiry into a topic. Simple advance organizers that provide a conceptual overview of what students will learn are often useful. It is also important to get students engaged in observing and talking about the phenomena that the unit will focus on. Encouraging observation of discrepant events, where students see things happen that their own conceptions do not lead them to expect, is useful. It is also useful to promote careful observation and thinking about everyday events or objects that play a significant role in students' daily lives, especially if you can ask provocative questions that will lead students to question how they understand those objects and events. Dialogue and debate among students can help them become aware of other ways than their own to think about the objects and events that they are observing. All of these techniques help students become actively engaged with the content of the unit.

Teachers can also learn a great deal from these initial discussions. By listening to students' explanations and ideas, they can begin to gain some insight into their students' prior knowledge and misconceptions. These insights will be of great use to them as they continue teaching the unit.

Introduction of Scientific Concepts

While such exploratory activities are useful, they do not in themselves lead to conceptual change learning (cf. Smith and Anderson 1984). Left to their own devices, students may discover many interesting things about plants or light, but they will develop scientific ideas about photosynthesis or vision about as rapidly as the human race: in other words, not in a single lifetime.

Therefore, scientific concepts need to be explicitly introduced and taught to students. Students must see the scientific concepts as important, meaningful, and comprehensible. They must understand that the scientific concepts are different from their own previous ideas, but not so strange or difficult that they cannot be understood.

We have found that students comprehend scientific concepts better when they are introduced in the context of a meaningful problem, not simply as facts or definitions to be learned. Thus, for example, the previously quoted passage in Ms. Lane's text explaining how we see will be more meaningful to students if they have been discussing the question before reading the passage.

Contrasting scientific concepts and common student misconceptions is also useful. Ms. Lane, for instance, can help her students by clearly pointing out that their explanations of how we see do not mention reflected light, but the book does; or she can help them understand that looking out of a window is actually detecting light coming *in*.

Finally, it is important to emphasize key concepts through such devices as repetition and highlighting (using bold print and putting key concepts in boxes). This may seem like obvious advice, but look at what is emphasized in a typical science textbook: the vocabulary words!

Application and Integration

Research on learning indicates that students initially learn new concepts in specific task contexts and often have difficulty transferring what they have learned to other contexts. This is true even if the concepts are in fact broadly and generally applicable. Thus students cannot fully master a new concept or appreciate its significance until they have successfully used it in a variety of different contexts.

Therefore each important concept should be included in a variety of different tasks, and its presence and importance should be explicitly signaled. For example, the idea that seeing is detecting reflected light can be used to explain why we cannot see through walls (do they block our "view" or the light coming toward us from the other side?), how our eyes work, how we see colors, why frosted glass makes things look blurry, and so forth. Only when students have successfully explained these and other situations can they truly be said to understand that we see by detecting reflected light.

Discussion of Instructional Strategies

One useful way of bringing together the teaching strategies discussed above is to consider a science classroom as a *learning community.* An ideal community for the learning of science needs to be different from a typical science classroom. Students should be actively engaged not just in learning facts and practicing skills, but in practicing the activities of scientifically literate adults: explanation, description, prediction, and control of objects and events in the natural world. Students in such an ideal learning community learn science from sources of *authority* such as textbooks and the teacher, from *evidence* that they acquire by working with natural objects and events, and from *communication* with each other and their teacher.

Creating such an ideal learning community in an ordinary classroom is not an easy task. Textbooks and other teaching materials are generally designed to support memorization and skill practice, not the understanding of science. Young children are typically curious about the world, but they are not naturally disciplined learners of science. Older students often habitually use learning strategies that help them get through science classes, but that does not lead to true scientific understanding. Teachers often work under conditions that do not encourage the creation of ideal learning communities. Nevertheless, we have seen Ms. Lane and other teachers use teaching strategies like those described above to create true (if not ideal) learning communities in their classrooms. They are truly engaged in cognitive instruction in science.

Conclusion

In discussing the problems that Ms. Lane and other teachers encounter in planning and teaching science, I have implicitly answered the questions posed at the beginning of the chapter. This concluding section makes those answers more explicit.

1. Is the framework for strategic teaching and learning developed in the first half of this book consistent with research in science? Yes, it is. I have tried to show in this chapter how successful learning and instruction in science has each of the characteristics of successful learning and instruction discussed in Part I of this book. Moreover, I have tried to portray strategic teaching in science as a complex and demanding enterprise. It is hard work, and it demands an understanding of science content, of students and their scientific thinking, and of appropriate teaching strategies. There are at least three ways in which we can work to help science teachers become more successful at strategic teaching in science.

First, we can improve science textbooks and other teaching materials. Roth and others have demonstrated in their research that it is possible to write textbooks that lead to much higher levels of student understanding than current commercial textbooks. Commercial publishers, however, produce what the market demands, which is currently broad content coverage, lots of facts, and lots of features. The true impetus for improvement in textbooks must come from the buyers, including members of the Association for Supervision and Curriculum Development.

Second, we can improve preservice and inservice teacher education to help teachers become aware of the issues discussed in this chapter, master cognitive instructional teaching strategies, and ask questions about their teaching that will lead to continued professional growth and development.

Finally, we can improve the conditions of teaching. Strategic teaching can become a widespread reality in the schools only if teachers have time for planning, grading, and professional growth, if they are rewarded for trying and using cognitive instructional strategies, and only if communities are formed in which teachers can help each other think about and try to improve their science teaching.

2. To what extent is the framework developed in Part I of this book helpful for planning sequences of instruction in science? I think it is very helpful, especially the generic planning guides: Planning Guide 1 for Thinking Processes and Planning Guide 3 for Strategic Teaching. The Planning Guide for Teaching for Conceptual Change that I developed for this chapter embodies the concepts in both generic guides. Specifically, the Planning Guide for Teaching for Conceptual Change conceptualizes science learning and instruction in terms of the three-phase process just like that used for other subjects, as well as particular teaching/learning strategies emphasized in Part I such as linking new information to prior knowledge.

3. What adaptions, if any, need to be made to teach low- and high-achieving students so that all students will benefit from cognitive instruction? I do not have a fully adequate answer to this question. In our studies we have expanded the percentage of students' understanding from the 0-20 percent range to the 50-80 percent range. This is clearly a great improvement, but we have yet to develop techniques that reach the lowest-achieving students. In particular, we suspect that we are not reaching (a) passive learners, (b) students who are frequently absent, (c) students who are learning-disabled or handicapped, and (d) students who are severely deficient in reading and writing skills.

I feel confident, however, that the path to improvement does not lie in special programs, particularly for low-achieving students. Instead, we need to find ways of creating classroom learning communities in which all students are full participants. Low-achieving students need very much to practice expressing their ideas, to listen to the ideas of others, and to have others listen to them.

This is one of many problems that I am still wondering about and working on as I look for better ways of teaching science. There is a sense in which strategic teaching and

Planning Guide for Teaching for Conceptual Change

Student Thinking	*Teaching Strategies*
Preparation for Conceptual Change	
Anticipate learning to take place, Develop adequate descriptions of natural phenomena, Develop awareness of, and dissatisfaction with, own explanations	Provide advance organizers, Generate observation, discussion and writing about everyday objects and events, Question and debate explanations, Generate observation and discussion of discrepant events
Introduction of Scientific Conceptions	
Achieve initial minimal understanding of scientific explanations, Understand scientific conceptions as reasonable alternatives to own reasoning (not too difficult to understand, not just additions to their own ideas)	Emphasize key principles and theories, Constrast misconceptions and goal conceptions, Introduce conceptions in the context of meaningful tasks
Application and Integration	
Understand scientific principles and theories as widely applicable, Understand interconnections with other personal and scientific ideas	Explicitly signaled inclusion of conceptions in other tasks, especially --tasks in everyday contexts, --tasks in other scientific contexts

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cognitive instruction in science are ideals that neither I nor any other science teacher can ever fully achieve. This chapter, however, describes many specific actions that teachers, administrators, and others can take to improve science teaching. Long-term improvements in science education will arise from the accumulation of those specific actions.

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Instructional Methods

What instructional methods support scientific thinking and problem solving? [*]

U.S. education is often criticized for paying too little attention to complex thinking and reasoning skills — the "higher-order" skills — that students need to become lifelong learners and flexible workers. According to the National Assessment of Educational Progress, performance gains in the 1980s occurred primarily in basic facts and low-level skills. Few students showed proficiency in complex reasoning and other higher-order skills.

Problem solving resists a simple definition. Experts suggest that problem solving be viewed as a continuum. At one end are exercises with solutions — such as how to balance items on a scale. At the other are problems to which no one has the answer, such as how to create conditions in which cold fusion will transpire. Problems typically assigned in science classrooms, such as blackboard demonstrations and end-of-chapter exercises, fall at the low end of the continuum.

The type of problem solving recommended in research more closely parallels the processes and habits of mind that scientists use, including logical reasoning, questioning, analysis, and hypothesizing.

The type of problem solving recommended in research more closely parallels the processes and habits of mind that scientists use, including logical reasoning, questioning, analysis, and hypothesizing. This form of problem solving helps students gain a deeper understanding than simply memorizing science facts. It can be a terrific motivator, especially if the problems address interesting, non-trivial, real world issues. And contrary to popular wisdom, it is appropriate for students of all ages.

One model from research asks teachers to guide students through four distinct stages of problem solving:

Invitation. A question from a student or the teacher invites students to learn more about concepts that intrigue them.

Exploration, discovery, and creativity. Students develop experiments and use other methods of inquiry, such as observation and revision, to begin to answer the initial question.

Proposing explanations and solutions. With support from the teacher, students develop, discuss, and debate explanations consistent with the results of their experiments.

Taking action. Students follow up on what they have learned through such means as writing a letter or initiating action in their homes or communities.

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[*] Kober, Nancy. (1993) *What Instructional Methods Support Scientific Thinking and Problem Solving?* **EdTalk: What We Know About Science Teaching and Learning.** Washington, DC: Council for Educational Development and Research (now National Education Knowledge Industry Association Communications.) Reprinted with permission of NEKIA Communications. Copyright 1993 by Council for Educational Development and Research. All rights reserved.

Another model for building problem-solving skills engages children in designing technological solutions to real-world challenges. Children engage in four phases of inquiry:

Investigation. A child poses a question, becomes aware of a need or problem, or accepts a challenge.

Invention. Students plan and design alternative ways to address the challenge.

Implementation. Students test and modify their original design.

Help students use the tactic of working backward from what they want to find out as they devise a plan.

Evaluation. Students evaluate both the product they developed and the process they used.

For example, in one classroom, second graders used half-gallon milk cartons to design a habitat for an animal they selected. The habitat had to include an offset wheel that would allow the animal to jump up and down. Students saw how important it was to measure accurately and to stabilize the wheel. They also researched the animal's movements. From this project, children synthesized design concepts, aesthetics, basic scientific principles, and language concepts.

Research contains other tips for teachers to make problem solving more effective. Among them are:

- Use intentionally open-ended questions.
- Help students see ways to keep track of their thinking steps as they solve problems.
- Encourage students to be active and use pencil and paper or other materials.
- Help students use the tactic of working backward from what they want to find out as they devise a plan.
- Use familiar procedures and equipment to introduce new problems.
- Encourage mobility and student interaction.

Different Learning Focuses Require Different Roles/Responsibilities for Teachers and Learners

What does your team want as the focus of learning?
And given your team's focus, what responsibilities and strategies do teachers and learners need to assume for high quality learning to occur?

Focus of Learning	Teachers' Responsibilities	Teaching Strategies	Learners' Responsibilities
Developing understanding of a concept via investigation and reflection	• Defines expectations in terms of concepts and skills identified in Standards, revising expectations based on students' preconceived notions and abilities. • Makes necessary preparations to insure adequate supervision and learning resources for learner.	• Provide repeated experiences for learners to ask questions, make choices, investigate and reflect on concept, revisiting it in different, real, immediate contexts over weeks or months. • Encourage learners to compare what they and others have found out, explain discrepancies, generalize, and apply what they have learned in new situations. • Provide a supportive learning environment in which learners can "risk" and try new things. • Integrate learning strategies and assessment strategies so that they influence one another.	• Ask questions, wonder about things, try new things based on previous experiences, expertise, self-confidence, and support of learning team/group. • Analyze and synthesize experiences/evidence to create explanations. • Apply learning/understandings to new situations. • Reflect on and discuss own progress with others. Analyze strengths and weaknesses and possibilities for improving. • Feel empowered to continue and direct own learning.
Exploration of a theme to achieve specific outcomes	• Identifies learner outcomes/expectations from Standards/Frameworks. • Draws activities from commercially produced materials or from a collection of resources. • Prepares materials and collects supplies learners will need.	• Use a combination of hands-on and minds-on activities. • May imbed activities in a hypothetical context/scenario. • Gives learners opportunities to choose within parameters of activity. • Periodically assesses what learners know and can do.	• Make observations and collect data to answer questions and reach conclusions. • Engage in new experiences, learning new ideas and skills. • Explain findings/learning and apply them in the context of subsequent activities. • Demonstrate skills and ideas learned when appropriate.
Hands-on activities – Active exploration and discovery	• Using commercially available materials or a collection of resources, plans hands-on activities for learners. • Collects and prepares materials and supplies as needed.	• Select student activities from a collection and directs students in using them. • May link a sequence of related activities. • Periodically evaluate what learners know and can do.	• Engage in active learning experiences. • May not have opportunities to "make sense" out of individual activities or a sequence of related activities. • Demonstrate what has been learned when asked.
Information transfer	• Familiar with student text and teacher's/curriculum guide.	• Implement sequences of readings and activities provided. • Prepare the lessons as specified. • Evaluate what students have learned at specified times.	• Learn the lessons presented. • Provide the "right" answers.

North American Association for Environmental Education

NAAEE is a network of professionals and students working in the field of environmental education throughout North America and in 60 countries around the world. Since 1971, the Association has promoted environmental education and supported the work of environmental educators. There are many environmental interest groups, and many organizations dedicated to improving education. NAAEE uniquely combines and integrates both of these perspectives, and takes a cooperative, nonconfrontational approach to promoting education about environmental issues.

The Association is made up of people who have thought seriously—over lifetimes—about how people become literate concerning environmental issues. NAAEE members believe education must go beyond consciousness-raising about these issues. It must prepare people to think together about the difficult decisions they have to make concerning environmental stewardship, and to work together to improve, and try to solve, environmental problems.

NAAEE recognizes the need for a coherent body of information about environmental issues. Its members also recognize that information and analysis are only part of an effective education program. To be truly effective, this body of knowledge must be integrated into all aspects of the curriculum and into all types of educating institutions for the widest array of audiences.

In order to translate theory into reality, and provide tangible support for environmental education and environmental educators, NAAEE engages in a variety of programs and activities. Some examples are the annual conference at varying North American sites, an extensive publications program, the NAAEE Professional Development and Training Institute, the VINE (Volunteer-led Investigations of Neighborhood Ecology) Network, the Environmental Issues Forums (EIF) program, the Environmental Education and Training Partnership (EETAP), and NAAEE's National Project for Excellence in Environmental Education.

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ISBN 1-884008-59-3